No. 3108

United States
Circuit Court of Appeals

For the Ninth Circuit.

GEORGE J. HENRY, JR.,

Appellant,

vs.

CITY OF LOS ANGELES,

Appellee.

BOOK OF ADDITIONAL ORIGINAL EXHIBITS.

Upon Appeal from the United States District Court for the Southern District of California, Southern Division.

Filmer Bros. Co. Print, 330 Jackson St., S. F., Cal.

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INDEX TO BOOK OF ADDITIONAL ORIGINAL EXHIBITS.

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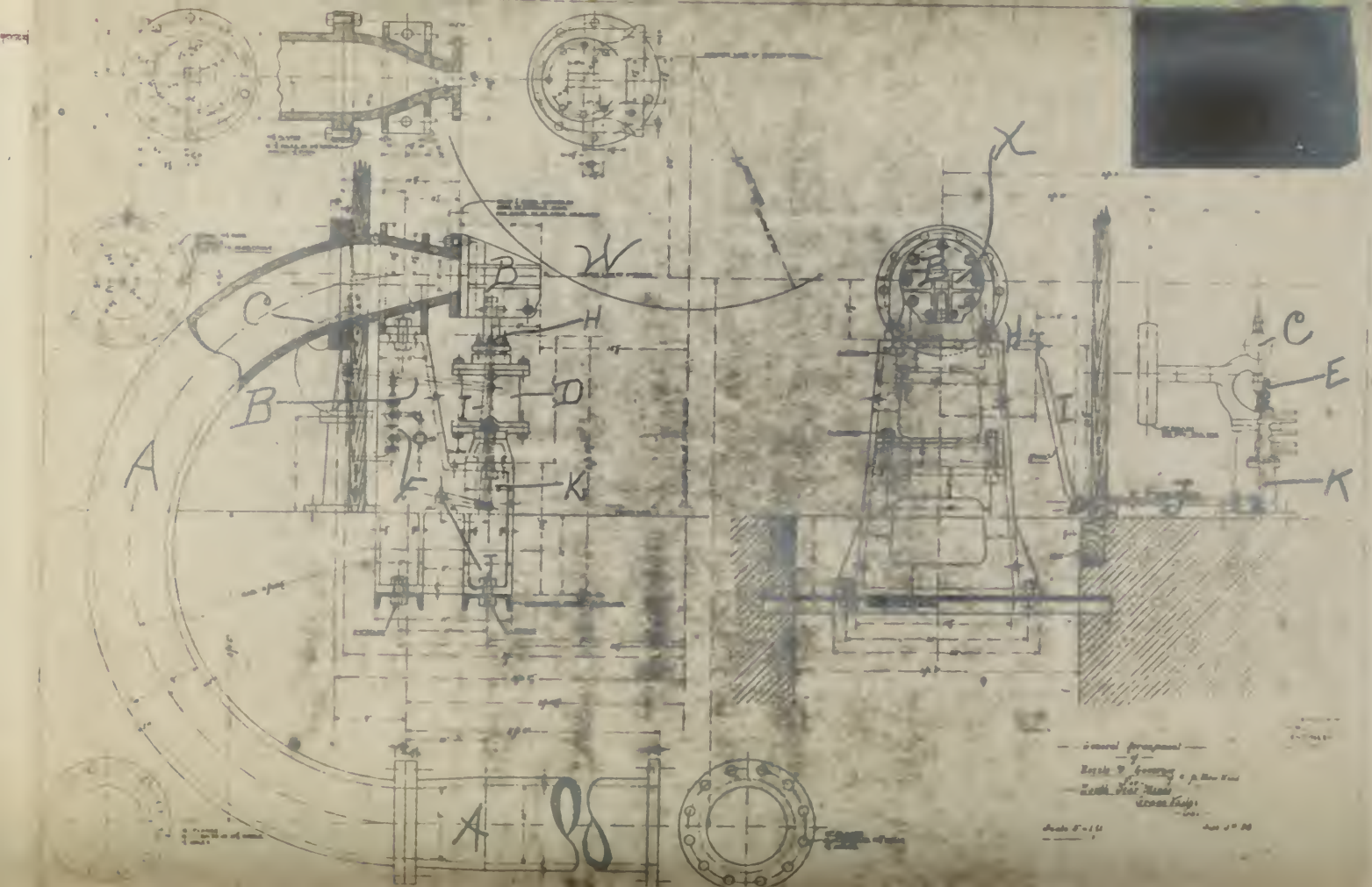
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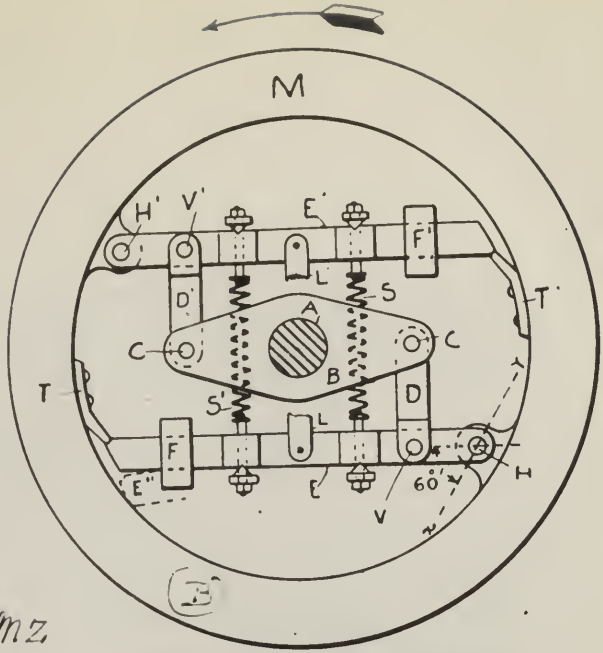

DETAILS OF THE GIRARD GOVERNOR.

U. S. Dist. Court
Southern Dist. of California
Southern Division
Geo. J. Henry, Jr.,
vs.
City of Los Angeles
Defendant
} In Equity
} A-87

Defendant's Exhibit MZ

J. Benjamin
Special Examiner
in Chancery

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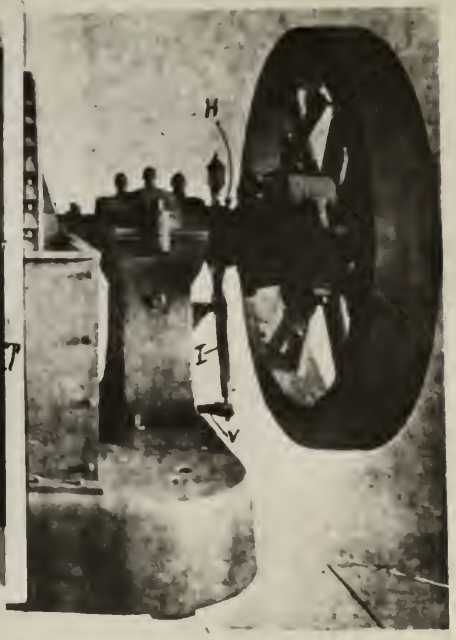
RAM, NOZZLE AND PASS-BY EQUIPMENT OF THE GIRARD GOVERNOR.



THE GIRARD FLY-WHEEL GOVERNOR.

Defendant's Exhibit "XX."

[Endorsed]: U. S. Dist. Court, Southern Dist. of California, Southern Division. Geo. J. Henry, Jr., Complainant, v. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit "XX." Apr. 1, 1914. I. Benjamin, Special Examiner in Chancery.

Edw. S. Cobb, 1121 Central Bldg., Los Angeles, Cal.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

Defendant's Exhibit "ZZ."

[Endorsed]: U. S. Dist. Court, Southern Dist. of California, Southern Division of California. Geo. J. Henry, Jr., Complainant, v. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit "ZZ." I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Edw. S. Cobb, 1121 Central Bldg., Los Angeles, Cal.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

Defendant's Exhibit Cobb Pressure Regulating Device Circular.

[Endorsed]: U. S. Dist. Court, Southern Dist. of Cal., Southern Division. Geo. J. Henry, Jr., Complainant, v. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit Cobb Pressure Regulating Device Circular. Apr. 8, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

IF YOU ARE USING A PIPE LINE FOR CONVEYING WATER THIS WILL INTEREST YOU.

The apparatus herein illustrated has been designed to use in connection with pipe lines conveying water for power or other uses, and is for the purpose of absolutely preventing the fluctuations of pressure, which occur in such lines when the flow of water is suddenly checked or changed.

The phenomena of "RAM" or shock in pipe lines have been observed by all, and many devices have been suggested for effecting a protection for the pipe against bursting, or other serious injury; but so far as we have been able to learn, none have been applicable to all conditions and few have been effective under any conditions.

The application of an air chamber of suitable dimensions gives to a pipe line an elasticity to resist

shock, not attainable with any other known device—and as far as receiving and absorbing the shock is concerned, probably no better device will be forthcoming. But where the flow of water in the pipe line is used to drive water-wheels, and when the quantity of flow is regulated by increasing or diminishing the area of cross-section of the nozzle, the use of an air chamber has presented some difficulties.

To illustrate, consider a pipe line, flowing full of water at a normal velocity under head or pressure, and discharging through an orifice of variable cross-section. Let this pipe be provided with an air chamber placed at a point preferably near the point of discharge; suppose that the cross-section of the discharge orifice be suddenly decreased, then the normal velocity of flow in the pipe line must be as suddenly checked; and the excess energy of the moving mass will be spent in, first: compressing to a greater degree the air confined in the air chamber; and, second: in giving an increased velocity of flow through the reduced discharge area.

The air in the air chamber thus compressed above its normal pressure will react and cause a return flow or rebound of water in the pipe line, the energy of which will be as great as the original excess energy of flow, less the loss due to friction, and this alternate flow and rebound will continue in action until friction has absorbed the excess energy of the moving mass.

The alternate flow and rebound above referred to, cause coincident increase and decrease of velocity of flow at the discharge orifice, and render the attain-

ment of uniform speed in the water wheel a matter of great uncertainty; even, when the best known forms of governors are in use.

The apparatus here illustrated, embodies the elastic air chamber to receive and absorb the shock, and the reaction of the air compressed above normal is prevented by introducing an automatic stop valve between air chamber and pipe line as shown—thus absolutely preventing any rebounding action, and coincident fluctuation of pressure at the discharge orifice.

The water which enters the air chamber during the compression of the air therein is discharged through a suitable waste valve at the side. This valve being opened by the excess of pressure above normal, that was entrapped in the air chamber, and closes automatically when the water discharging from the air chamber has reduced the pressure therein down to normal conditions. It will be observed that under this arrangement—

1st. Only that amount of water is wasted which is passed through the air chamber as an exact measure of the energy of the "Ram" overcome.

2nd. That under normal conditions, the pressures in the air chamber and pipe line are equal, and hence the automatic stop valve between air chamber and pipe is in balance.

3rd. That in most situations, the simple arrangement shown in Figure 1, may be used, as the confined, non-fluctuating, excess pressure in

the air-chamber is an ideal medium to operate a safety valve as there shown.

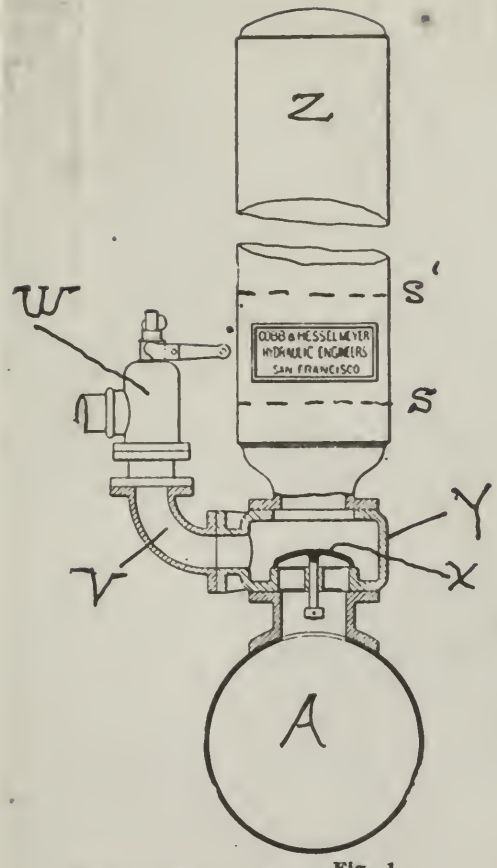
4th. That if an exceptionally close regulation of pressure in the pipe line is desired, other arrangements not shown may be used, wherein the discharge valve from the air chamber is operated by an hydraulic cylinder, the piston of which receives on one of its faces the pressure of the air-chamber, and on its opposite face a constant pressure, from the accumulator shown, exactly equal to the normal working pressure of the pipe line.

5th. That full information in regard to this device as applied to any pipe line under any conditions, will be cheerfully given.

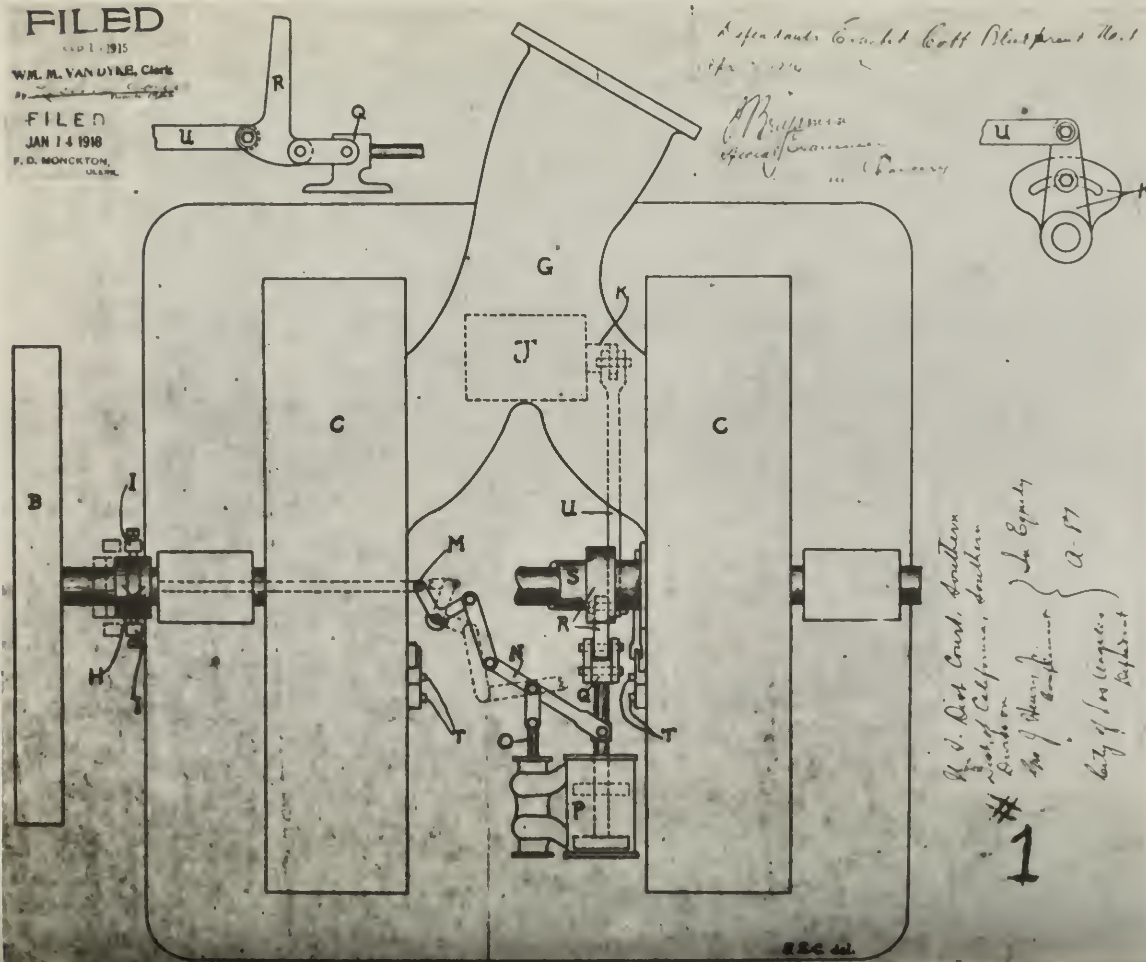
EXTRACT
from
Page and One-Half Editorial
in
"ENGINEERING NEWS."

July 8, 1897.

* * * * * "The reader who has followed the above discussion can now form an intelligent opinion as to the merit of the device of Mr. E. S. Cobb, described in Mr. Richards' paper. It appears to us to be an excellent device, and likely to prove effective if properly designed. We desire to call especial attention to the waste valve of this device, which appears to us likely to prove the best method for controlling the flow in long pipes and solving the difficulties in governing the speed of wheels, and in controlling the pulsations and shocks in the pipe to which we have referred. Such relief valves should be proportioned to the size of the pipe they control, and should be located as near to the nozzle of the pipe as practicable. They should be so loaded as to open automatically when the pressure in the conduit rises somewhat above the normal working pressure, and would then act to prevent the further increase of pressure in the pipe. The water wasted through them would be comparatively small in amount and would furnish, we believe, the cheapest and simplest way of taking care of the energy that appears when the velocity of flow in the conduit is checked." * * *



PATENTED AUGUST 3, 1897 **Fig. 1**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In Equity
City of Los Angeles
Defendant


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Defendant's Exhibit Interior of Power Development Co's. Power House.

[Endorsed]: U. S. Dist. Court, Southern Dist. of California, Southern Division. Geo. J. Henry, Jr., Complainant, vs. City of Los Angeles, Defendant. In Equity—A. 87. Defendant's Exhibit Interior Power Development Cos. Power House. Apr. 1, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Return to Edw. S. Cobb, 1121 Central Bldg., Los Angeles, Cal.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

Defendant's Exhibit Cobb & Hesselmeyer Report of August 8, 1896.

San Francisco, Cal., Aug. 7th, 1896.

POWER DEVELOPMENT CO.,

San Francisco, Cal.,

C. N. Beal, Secretary.

Dear Sir:—

We present herewith a synopsis of the claims made by the several bidders for Water Wheels and Governors to be used in your power house near Bakersfield, Cal., also a general description of the operation of the special form of plant proposed by them and detailed description of their several operating devices, and our opinion in reference to the best proposal for you to adopt and our reasons for this opinion so far as the same can be briefly set forth.

The "Outline Specifications" furnished to bidders as a basis and guide for their proposals called briefly for the following items to operate according to the conditions given: First, two sets of water wheels to develop 750 H. P. each when running at 257 R. P. M. under an effective head of 190 feet; second, each set to be entirely independent, self-contained and complete with all details and accessories for operation; third, approved automatic governing devices to regulate speed in the varying conditions of load; fourth, guaranteed water efficiencies, and guaranteed percentage of perfect regulation under varying conditions of load.

In full response to the requirements of the above specifications, three proposals and bids for the required machinery have been received from the following firms:

Risdon Iron Works, Knight Wheels;
Pelton Water Wheel Co., Pelton Wheels.
Girard Water Wheel Co., Girard Wheels.

These will be referred to hereinafter as Risdon, Pelton, Girard, and as each firm proposes to install two sets of wheels, one set of each make need only be considered in further description and comment. The proposals submitted by the above three firms cover the requirements of the specifications and hence need only more minute consideration in connection with the special means and methods proposed for accomplishing the results required.

Risdon proposes as follows: Single Knight Wheels 48 inches in diameter, 750 H. P. at 257 R. P. M.—199.4 feet head, multiple nozzles gate operated by

hydraulic cylinder for stopping and starting wheels, said cylinder in turn operated by hand levers placed near switchboard or a second set of hand levers near generators and an extra plain gate to be closed by hand in case hydraulic gate should need repair, water supply to wheel (and hence regulation) effected and controlled by use of the Butterfly valve in pipe leading to multiple nozzles, said Butterfly valve receiving its required movements from a Knight combined mechanical and electrical governor. Water supply to wheel further regulated for large changes of load by a slide back of the multiple nozzles, said slide operated by hydraulic cylinder, which in turn is controlled by hand levers; this slide cuts off power of the wheel in divisions each equal to one-sixth of the full power of wheel, hence in operation under any specified load the slide is moved by the attendant until the least number of nozzles is open, which will give more power than is required and the governor through the medium of the Butterfly valve then controls the speed.

Under these conditions of construction, if wheel were operating, for example, under full load (i. e. slides set by attendant with all nozzles open and governor controlling speed by means of Butterfly valve) and if the load be suddenly removed governor will immediately, i. e. in 12 seconds, partially close Butterfly valve, thereby reducing velocity of water at impact and causing an equivalent increase of pressure or water ram in the pipe line back of the Butterfly valve. This resultant water ram is injurious to pipe line and attachments and would be dangerous

to same were its effects not rendered less harmful by the added elasticity of the pipe line due to the addition of an air chamber; again suppose that wheels are running properly at 55% of full load (i. e. with slides set by attendant so that four out of six slides are open and governor controlling speed as before through the medium of Butterfly valve) and that full load be suddenly required of the wheels, governor will then move Butterfly valve to position full open, but as only four nozzles are open at wheel full load cannot be carried at proper speed until attendant shall move slide back of multiple nozzles, so that six nozzles are open (full load requirements).

From the above it will be understood that the above-described methods and mechanisms appear to require and in our opinion do require the close attention of the attendant if sudden charges of load are liable to occur.

Pelton proposes: Single 48 inch wheels 750 H. P., 257 R. P. M., 187 feet head. Multiple nozzles, each wheel supplied with cast iron multiple nozzle, each nozzle of the set having a movable tongue for regulating the area of discharge opening. These movable tongues are moved in unison by suitable mechanism, and may be operated either by hand or by the Replogle Relay Governor which they propose to use in connection with their wheels. By means of a gate operated either by hand or hydraulic cylinder, one or two-fifths or total power of the wheel may be cut off. If hydraulic cylinder is used for operating this gate, it may be controlled from the switchboard or any other convenient location. Regulation of speed

is guaranteed as follows: That the speed will not vary over

3%	From normal	with a	10%	change of load.			
4%	"	"	"	20%	"	"	"
5%	"	"	"	30%	"	"	"
6%	"	"	"	40%	"	"	"
7%	"	"	"	50%	"	"	"

They say that they can improve the above by making larger and heavier fly wheels.

The Pelton device shown on their blue prints and set forth in their proposals has in action the same effect upon the flowing column of water in the pipe line as has been briefly mentioned in connection with the Risdon proposal and the same attention, required by the attendant as there mentioned when load varies from about 60% to full load, will be required in the Pelton construction. That is to say, the main gate will have to be operated by the attendant to open up nozzles not previously in use.

Girard proposes: Two 44 inch wheels and one shaft to develop 750 H. P. at 257 R. P. M. and 190 feet effective head. Buckets cast solid in the wheels. Nozzles made of gun metal and made to templates and interchangeable. The governor proposed is of a similar type and construction as that used on the modern high speed engine, and its parts take a new position with reference to the shaft with every change of speed or load. Its action is quick and has sufficient power to control the valve of a hydraulic, brass lined cylinder, which in turn determines the flow of the water through the nozzles. The nozzles are supplied with a contracting element which is at all

times in balance and will operate the wheel at normal speed from *no load to full load without the necessity of any attention whatever* from the attendant, and it is guaranteed "that there shall not be more than 5% momentary variation when 25% of the power is thrown on or off suddenly."

By a simple device similar to an ordinary plug cock inserted in a branch from the main supply pipe just back of the nozzle, a complete prevention of any water ram in the pipe line is attained. This rotating, balanced valve is connected to the same hydraulic cylinder that operates the nozzles and in such a manner that when the nozzles are contracted this valve is open and the area in cross section exactly equal to the area of contraction of the nozzle opening, and if the nozzles open this valve closes off an area exactly equal to the added areas in the nozzles. The result is that when water is shut off from the wheels, it escapes through this valve, and when more is wanted on the wheels less is allowed to escape, thus attaining a constant flow of water in the pipe line and hence no water ram whatever or the attendant fluctuations of pressure.

They further suggest and propose to supply constant speed motors to operate the excitors independently. This method of giving constant speed to the excitors independent of varying load and speed of generators is important and of practical value in the attainment of the best results electrically.

Having in the above given briefly the points claimed by each of the parties presenting complete proposals, and having given all of their devices care-

ful study from both a theoretical and practical standpoint, we present our opinion on these proposals as follows:

In the special plan under consideration, the mere fact that only such water flows through the pipe line as is necessary to develop the required power at any particular time is not important from the fact that all water not allowed to flow through the pipe line up to its full capacity at full load will in any case be wasted over the waste-way at the foot of the flume. The features demanded in this plan are:

Greatest attainable uniformity of speed.

Quick and certain variations of power to conform to variation of load.

All mechanism of the simplest possible construction and having wearing surface adjustable. Few parts liable to derangement or breakage and all made of superior materials and of first-class workmanship.

The whole so devised and arranged as to require the least possible attention from the attendant.

We are of the opinion that the proposal which most nearly fulfills these requirements and many other desirable features of less importance is that presented by the Girard Water Wheel Company, which is by far the simplest mechanical construction —hence greatest freedom from derangement—is entirely self-acting and self-regulating after starting, requires the least attention during its operations, and embodies in our opinion the *best system of governing* that has been presented as adapted to this plant.

If upon careful consideration you should arrive at the same general conclusions as ourselves and deter-

mine to use the proposal presented by the Girard Company, we would recommend that you require of them that the main gate be opened and closed by hydraulic cylinder, having its water supply pipes so arranged that the speed of opening or closing may be properly adjusted to the conditions, and that the levers for its operation be located at convenient positions for attendant. Also that they arrange the pipes leading from the Receiver to the gates to conform to a lower position of the Receiver as now determined upon.

Respectfully submitted,
COBB & HESSELMEYER,
Per C.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. Geo. J. Henry, Jr., Complainant, vs. City of Los Angeles, Defendant. In Equity—A. 87. Defendant's Exhibit Cobb & Hesselmeyer Report of August 8, 1896, April 1, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Report on Wheels for the Power Development Co., San Francisco, Calif. C. N. Beal, Secy. Aug. 8th, 1896. Edw. S. Cobb.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

Defendant's Exhibit Cobb Efficiency Report.

REPORT OF EFFICIENCY TESTS
of
GIRARD WATER WHEELS, AT
the Power House of the
POWER DEVELOPMENT CO., KERN CO., CAL.

GENERAL DESCRIPTION.

The Power Plant of which these wheels form a part consists of two units which will hereafter be known as units #1 and #2 they were designed to be alike in every respect and both units were made and set from the same drawings.

Each unit consists of:—

A. Two 44″ Girard Water Wheels mounted on one shaft, but each in a separate casing, and each provided with nozzles where jet cross section may be varied to conform to different loads.

These nozzles are operated by levers and Rocker-arms from an hydraulic cylinder. This hydraulic cylinder also operates a large cylindrical by-pass valve, and is itself controlled from the shaft governor to be more fully described.

B. Forming the driving connection between the Water Wheel Shaft and its load is the governor mechanism, which in appearance resembles a shaft governor, but which in fact, is a transmitting dynamometer; a part of the mechanism of this shaft governor is rigidly attached to the water wheel shaft and a part is rigidly attached to the shaft of the electric generator, which forms the remaining element of the unit.

C. This Electric Generator is known as a 450 K. W. General Electric Three-Phase Alternator. Its exciter is driven by belt from the rim of a heavy fly-wheel which forms the enclosing wheel for the governor dynamometer mechanism above mentioned.

The water for operating the water wheels is led to them under an effective head of 188.06 feet from bottom of forebay to center of water wheel shaft, plus height of water in forebay varying from 3.5 to 5 feet less friction in pipe line a net head of not less than 190 feet exclusive of friction in goose necks and passages to water wheels which loss is to be borne by Girard Water Wheel Co. E. L. C.

In the pipe system leading water to the wheels and as near them as possible is located the above-mentioned by-pass valve, the area of whose outlet is sufficient to allow all the water required by one unit at full load to pass through it into the tail-race before reaching the nozzles at the wheels and its arrangement and connections are such that when the nozzles are full open this by-pass is entirely closed and when nozzles are fully closed the by-pass is wide open, intermediate positions in proportion.

It will be observed that by this arrangement a constant flow of water is maintained in the pipe-line without regard to actual quantity used on wheels.

At certain seasons of the year the water is so loaded with sand and fine float material that its use to operate the above-mentioned hydraulic cylinder was found inexpedient and oil was substituted for this purpose, and arranged as follows:—A supply tank set at a low level outside the power house is charged

with about 40 gallons of oil, which is pumped, by a belt driven plunger pump located on the water wheel bases, into a surge tank located within the power house.

The top of this surge tank is connected to the top of the large air chamber on the pipe line, and its capacity is greater than the whole supply of oil in use. The pumps run continuously with the unit and when all the oil is pumped into the surge tank from the supply tank they, by continued motion, pump air, which keeps up the supply required in the air chamber.

By this arrangement sufficient oil is always on hand in the surge tank, at the same pressure as the water in the pipe-line, for the operation of the hydraulic cylinder, and the spent oil from the hydraulic cylinder returns to the supply tank by gravity to be again used in the same circuit.

THE GOVERNOR DYNAMOMETER, forming the driving connection between the water wheel shaft and the generator shaft is constructed as follows: See Fig. I which is an outline view of the mechanism looking toward the generator, in which A. is the water wheel shaft, upon which is rigidly keyed the double crank; B. having at its extremities the crank pins C. & C′ which by means of links D. & D′ are connected to swing levers E. & E′.

T. is a wheel having suitable spokes and a flange (not shown) for attaching same rigidly to generator shaft. The swing levers E. and E′ are attached to wheel T by pins H and H′ and when full load is being transmitted the outer end of these levers rest on or are near to stops V. & V′ attached to inner

surface of rim of wheel T. When full speed is attained with no load these swing levers take the positions shown in dotted line at U and U′ with their outer ends in contact with or near the inner surface of the wheel rim.

Between the levers E. and E′ are strained the springs S and S′. At the points F and F′, which are diametrically opposite each other and also midway between the extremities of the two springs S and S′, are attached one end of each of two bell cranks (not shown) the remaining ends of which give longitudinal motion, along the shaft A, to a collar or sleeve which in turn, by a system of levers, operates a balanced valve for controlling motion in the hydraulic cylinder, which operates by-pass valve and nozzles.

The above general description of the water wheel units will make such details as are referred to in this report of the test more readily understood.

On a previous occasion a trial was made of the operation of a set of water wheels that had been supplied by the Girard Water Wheel Co., under conditions varying from no load to full load. And measurements of output in useful effect were made by reading the instruments, on the station switch board, that were supplied as part of the plant by the General Electric Co.

There then appeared a wide discrepancy between this quantity of water used or the effective work it should have performed and the actual, effective work output shown by the switch-board instruments even

after liberal allowances for efficiencies had been made.

The discrepancy shown and the lack of faith of the Girard Co., in the form of buckets which they used in their wheels, led them to change that portion of the wheels which contained the buckets and replace them with those portions now in position. After the new wheels were completed and tested by them the Girard W. W. Co., set up the following claims:

1st. That the instrument used in measuring the effective output at the former trial above mentioned, were defective.

2nd. That the shortage of output may have been caused by a much lower efficiency of the generator itself than had been allowed for.

3rd. That their water wheel governor as constructed and applied was a transmission *dynamometer* giving an accurate measurement of the power passing through it to the generator shaft.

4th. That from knowledge at their command, they say that the wheels *do* deliver the required effect to the generator shaft, as was shown to their satisfaction at their own trial above mentioned.

5th. That carefully made tests will prove the accuracy of their claims and,

6th. That they now submit the wheel units for final test under the contract.

THE TESTS:

Then, a report of which follows, were made:—

A. To determine the accuracy of their above enumerated claims and B. To determine whether the

guarantees given in their contract respecting all matters of workmanship and material, horse-power of work delivered to generator shaft, and efficiencies of operation at different loads had been complied with.

Their claims as above need not, then, be repeated here; They further by contract dated, Fourteenth day of August A. D. Eighteen hundred and Ninety-six, agree and guarantee as set forth in the following extracts therefrom:

(Page 1) 1st. "All material furnished and all work done by contractor shall be first-class in every respect"; and the contractor shall replace and make good, without extra cost, any defects of workmanship or material which may be discovered within four months after date of final acceptance of the work" by the Power Development Company."

(Page 4) 2nd. "Each unit under normal conditions to be capable of developing and delivering to the shaft of a 450 Kilo Watt General Electric Company's triphase alternator, directly connected with such unit, 750 effective horse-power when operating under an effective head of 190 feet and at a speed of 257 revolutions per minute."

(Page 6) 3rd. "An hydraulic cylinder, which shall open and close the apertures in the contracting and expanding nozzles, and shall simultaneously open and close balanced rotating valves in the conduits in such manner that the flow of water in said conduits shall be uniform at all times when wheels are in operation."

(Page 7) 4th. "Efficiencies:—The contractor

guarantees that the wheels supplied by it will develop and deliver to the generator shafts when operating at full load, three-quarter load, or half load, eighty-five per cent of the theoretical power of the water applied to the wheels; and when operating at one-quarter load, will develop and deliver to said shafts eighty per cent of such theoretical power."

(Page 7) 5th. "The Contractor also guarantees that there shall not be more than five per cent variation in speed of the water wheels when the load for the time being carried is suddenly increased or decreased 25 per cent; and that such variation shall not continue for a period exceeding three seconds."

In consideration of claims 3 and 4 as set up by the Girard Water Wheel Co., it was determined that the first measurements taken should be those necessary to arrive at the correctness of those claims.

This made it necessary to first measure the tensions of the springs in the governor mechanism and these measurements were made as follows with the results there shown. See Diagrams 1 & 2.

Both of the links D. & D′ connecting the crank pins C. & C′ to swing levers E & E′ were removed and lever E′ forced to its maximum outward position as shown at U′ Fig. 2 and then securely blocked. The wheel T was securely blocked in such position that, when lever E was in position half way between that shown in full lines in Fig. 2 and that shown by dotted lines at V, it was level.

A force was applied at the point O in the direction of the line X. Y. of such intensity as to move the lever out, against the tension of the springs

S. & S′, to the position shown by dotted lines at U, when the outer end of the lever E. was as near the inner surface of the wheel rim as would just allow the passage between them of a piece of ordinary writing paper, the force necessary to do this was found to be in measurement #1 1437 lbs., in measurement #2 1428 lbs., average say 1432 lbs.

Both measurements were made by using a long lever, the short end of which was placed under the lever E. at the point O. with a steel plate and piece of round iron as a knife edge; and whose fulcrum was formed by a bar of 1″ round iron supported in the load chain of a traveling crane.

This fulcrum was raised, as the end of the lever E. raised, so that lever was always kept in a level position. The following are the details of these measurements, see diagrams.

The above average force at O. multiplied by its leverage about the pin H. i. e., 40.4″ and divided by the distance, 20¼″ between pin H, and pin F. will give the force, which acting at the pin F. midway between the springs S. & S′ would be equivalent to the above force i. e.—2857 lbs.

Hence 2857 lbs, is the force acting, radially, outward at the pin F. and also at pin F′ which will extend the springs S & S′ to such an extent that the levers E. & E′ will take their maximum outward positions, as shown at U & U′ in Fig. 1.

Now when the dynamometer was revolved at 257 Rev. per min. with all parts connected up as shown in Fig. 1, and *no* load is carried by or transmitted to the generator shaft, except a very small power

required to revolve it at that speed, it was conclusively shown that the swing levers E. & E′ with their superimposed weights and attachments as shown in Fig. 1 were thrown by centrifugal force, against the tension of the springs, out to their extreme positions as shown at U. & U′, which is conclusive proof that, at 257 rev. per min., the weight of levers and their attached parts was sufficient to produce a centrifugal force of 2857 lbs. intensity at the point F. between the springs S. & S′. Now when the levers E. & E′ are at their outer-most positions the points F. & F′. revolve in a circle 27⅞″ in diameter, 13 15/16″ radius.

It is now necessary to determine the initial tensions of the springs S. & S′ in order that we may know their full effect in retarding the action of centrifugal force in the levers, etc., and this was determined by allowing both levers E. & E′ to rest on their stops V. & V′ with no other connections between than except the springs S. & S′ and a force applied, by lever as in the former cases, at the point O. that was just sufficient to raise the end of lever E. from the stop V. sufficient to allow passing a thin piece of paper, between them. This force applied at O. was found to be 415 lbs. which reduced to find equivalent force required if applied at point F. or F′

$$\text{gives} \quad \frac{415 \times 40.4 = 828 \text{lbs.}}{20.25}$$

Now when the levers E. & E′ are drawn in so as to rest on their stops V. & V′ we have 828 lbs. as the force which is acting radially inward at each point F. & F′ to keep them there.

And the points F. & F′ revolve in a circle 24⅛″ diameter a 12 1/16″ radius when the system is revolved with the levers in this position.

When the whole is revolved at 257 Rev. per min., the above tests and calculations show that a centrifugal force of 2857 lbs., acts at both points F. & F′ when the levers are in their maximum outward position i. e. when the points F. & F′ are revolving in a circle 13 15/16″ radius.

And if the system be revolved at 257 rev. per min. and the levers E. & E. are prevented from moving outward, but are held so that points F. & F′ continue to revolve in a circle 12 1/16″ radius, then the effect of the weight of these levers to produce centrifugal force will be reduced in proportion to the reduced radius of revolution or 2857÷13 15/16″=2472÷12 1/16″ giving under these conditions 2472 lbs. as the radial, outward centrifugal effect of the weight and levers under the above conditions at 257 Rev. per min.

We have seen that with the levers in this identical position we had an inward pull applied at the same point of 828 lbs. due to initial spring tension. Hence the net outward force acting at the points F. & F′ when the levers are in their innermost position and when the whole is revolved at 257 Rev. per min is 2472 lbs. minus 828 lbs. or 1644 lbs.

As the only force which can hold these levers in the above mentioned position under a speed of 257 rev. per min, must be transmitted through the pin H. in the wheel T. which is attached to the generator shaft as before explained, we have (See Fig. 3) line

X. Y. to represent direction of resultant forces which cause wheel T. to revolve in the direction indicated by the arrow, and when parts are in the positions above assumed, this force line X. Y. makes an angle of 60° with the center line of the lever E., and the lever length between this force and the pin R. used as a fulcrum becomes 7″xcos 30°=.866x7″= 6.06″ from which, we have, the following 1644x13.25″ =6.06 X force acting in line X. Y. or force acting in line X. Y.=3594 lbs., and as this identical tangential force is acting on two points of a circle 4 ft. in diameter, we have as the foot pounds transmitted under these conditions.

$$\frac{3594 \times 2 \times 12.56 \times 257 = \text{H. P. transmitted} = 703.1.}{33000}$$

In further consideration we will call the length of the line drawn through pin R. normal to force line X. Y., the *Back* Lever length which must of course vary as the levers are thrown outward from the position above discussed.

And when the levers are at their extreme outward position this "back lever length" becomes only 5.7″ by reason of the different angle thus formed between center line of lever E. and force line X. Y.

From carefully made tests it has been shown that the springs used give practically equal extension for equal addition of load and hence we are, by reason of this fact and in accord with the results of the above described tests, enabled to construct the following table of, Horse-Power transmitted, when Dynamometer levers are in different positions be-

tween *no load* and full load and when revolved at 257 rev. per min. See table #1.

Before proceeding further with tests of the complete unit, under various loads; it was determined to test this variation, if any, in readings given by the instruments on the switch board, for this purpose there had been provided by the General Elec. Co's. Engineers, one Weston Calibrated Ampere-meter reading to 200 amperes and one Weston Calibrated Volt-meter measuring to above 600 volts.

Three of the Ampere meters were put in the same circuit with the Standard Ampere-meter and the following table gives the readings of the several instruments at the same instant of time.

All Ampere readings above 200 were read only on the Station instrument as the Western Ampere-

~~Western~~

meter reached its limit at 200 Amperes.

TABLE #4—

It will be observed that no two instruments read alike and no one like the standard, also that variations of reading were not constant so that the probable error could not be calculated and provided for.

Under these conditions it appeared best not to rely upon these instruments in determining the power output of the water wheels, but instead to use the dynamometer readings as shown in Table. I. as the more accurate measure of the actual work done.

In order that the exact position of the swing levers E. & E′ should be accurately determined and automatically recorded for any particular load for which such reading was desired, the following de-

vices were employed: See Fig. 4 where T. is the rim of the wheel enclosing the dynamometer levers of which one, E′ as shown was used. Attached to lever E′ was the spring pencil X., so arranged as to perfectly rigid except in a direction normal to side of the wheel rim.

The post Z. was arranged so that its outer end was much further from the wheel rim than all other near-by parts and between this post and the spring pencil X. a thread could be stretched to hold pencil off of paper when desired. Positions of parts were such that if the pencil was held off of the paper by thread as above described and when the whole was in revolution, the thread could be cut by simply holding a knife in the path of its revolution and the pencil thus allowed to drop onto the papers.

Across the paper at K. is drawn a line radial from the pin H′ Fig. 1. and at a distance from it, equal to the maximum travel of the pencil is drawn another radial line m.

The pencil will be at the line K. when the dynamometer is carrying full load or when it is not in revolution, and will be at the line m. when dynamometer is revolving at full speed but transmitting no power.

It must now be understood, that if the pencil is always allowed to stand in contact with the paper, when the machine was at rest it would be found at line K. and then as speed was attained it would travel outward toward M. reaching that line when speed had reached 257 rev. per min., if no load was transmitted, if now load be added, the pencil would

return in the same line toward line K. again a distance in proportion to the load being carried.

Hence, during the tests a description of which is to follow, the unit was stopped after each set of readings had been made and a thread applied to hold the pencil X. off the paper until such time as that load had been applied the measurement of which it was desired to record. Also for each test the pencil was so adjusted as to draw a fresh line on the paper as shown in Fig. 4 where a. represents the length of line for no load transmitted,

b. represents the length of line for ¼ load transmitted,

c. represents the length of line for ½ load transmitted,

d. represents the length of line for ¾ load transmitted,

and f. being only a point in the line K. shows full load transmission.

And when once the pencil had been allowed to fall upon the paper the load was not removed until revolution had ceased, hence the length of the line drawn on the paper (for example the line d.) represents that part of the whole possible load that was *not* being transmitted at the instant the pencil was allowed to rest upon the paper (in this example the line d. being ¼ as long as possible between lines K. & M. shows that the least power being drawn was ¾ of full load). This measurement made as above is that given under "Arm swing measurement" in Table 2.

For measuring the water used by water wheels, a

weir had been built, at some distance from the power house, at such height that a considerable depth of water was maintained in the tail race. And special care was taken to note, that at no time did the water reaching the weir have what is technically called initial velocity.

The water, which at all loads, except full load, escaped from the by-pass valve was piped away from the tail race. Eight carefully conducted trials were now made of the wheels and generator output as recorded by the several devices and instruments and the readings of these trials are given in #3 to #10 inclusive Table #2.

These being the trials made when the water rheostats were in use to produce load.

#3 & #8 were as near as may be ½ load trials;
#4 & #7 " " " " " " ¾ " "
#5 & #6 were as near as may be full load trials while
#9 & #10 " " " " " " ¼ " "

There appears to be an inconsistency in the water readings of these two latter trials which did not appear at the time the readings were taken and only appeared when reduced to tabular form.

The readings of the heads causing flow at the weir were reduced to Water Horse Power as follows:

The lip of the weir was 125.85 inches long and without end contractions. The Francis formula $Q=.4\ 1\ h\ 3/2$ was used wherein, $h\ 3/2=V\ h^3$

Q=quantity of flow in cu. ft. per min.
1=length of lip of weir in inches
h=head causing flow in inches, hence

Q=.4 1 h 3/2 becomes Q=50.34 h 3/2

Pressure gauges applied to pipe-line as near as possible to centers of wheels give pressure of 82. lbs. As the water was supplied, however, at 190 ft. head we have one cu. ft. of water per min.=.359 H. P. and the above formula gives H. P.=.359 x cu. ft. per min.=18.07 h 3/2 from which column O. in table 2 and column U. in table 3, were calculated.

Table 3, shows the, Horse Powers, calculated for the different parts of the unit tested, from the data given in "table 2." and also in column W. gives the efficiency of the water wheels under different loads when dynamometer measurement was taken as the Horse Power output, column U. and theoretical water horse power was as given in column V.

Tests were then made to determine the variation of speed attendant upon changes of load and the results of these observations are set forth in the following table:

TABLE 5.

5/16 load raised suddenly to 7/16 load tachmeter readings minimum 250 to maximum 260; 7/16 load raised suddenly to ½ load tachmeter readings minimum 248 to maximum 260; ½ load raised suddenly to ¾ load tachmeter readings 245 min. to max. 262; ¾ load dropped suddenly to ½ load tachmeter readings min. 247 to max. 270; ½ load raised suddenly to ¾ load tachmeter readings 245 min. to max. 262; ¾ load dropped suddenly to ⅜ load tachmeter readings min. 245 to max. 272; Loads changed by changes in water rheostat.

The speed readings during all the tests were taken from a fixed tachometer driven by a belt from pully on generator shaft.

These tests as recorded in the several tables #1—#2—#3—& #4; then indicate that claims 1 & 3 as set up by the Girard Water Wheel Co., are well founded and true.

In regard to their claim #2, concerning efficiency of generator, no tests were made at this time, former tests made at the factory of the General Electric Co., by Mr. Cary T. Hutchinson, as reported by him, showing such results as to have been satisfactory to the Power Development Co.

In regard to their claim #4, that the wheels do develop the required power; the tests show that the maximum power transmitted through the dynamometer was but 703 H. P. although it is readily believed that the spring tensions and weights can be so adjusted that dynamometer will transmit 750 H. P. at 257 rev. per min, and that power can probably be derived from the wheels as during these tests here recorded, there was still more area of nozzle opening to be used had it been required.

Considering the guarantees as set forth in the contract with the Girard Water Wheel Co., and as stated above in this report. We find from page

1st: From careful inspection of the material and workmanship we find that the material is first-class and that the workmanship is above the average on this class of work, except in the following particulars.

The by-pass valves are not reliable and have so far

given a great amount of trouble and should be replaced by a construction that will render it possible to operate them with certainty by the Hydraulic Cylinder provided in part for that purpose.

The oil pumps for keeping up the supply of oil in the surge tank are driven far too fast, they should be reduced in speed to not more than one-half that now maintained. The present high speed causes hammering in the pipes and is too great when area of valve passages is considered. If reduction of speed as above does not incidentally allow the gears on the pumps to run noiselessly, then cut gears should be provided in their places.

Oil cups suitable for "solid oil" or "cold grease" should be provided and applied to the six principal pin bearings in the governor mechanism.

2nd. The tests show that under an effective head of 190 feet the wheels developed, by dynamometer measurements as hereinbefore set forth, a maximum of 703.1 H. P.

It is believed that the dynamometer can be so adjusted at to measure a transmitted load of 750 H. P. and in our opinion if such adjustments were effected, the nozzles being allowed to open to their full extent, the wheels would develop the power called for in the contract.

As the dynamometer was set during the tests here reported on, 703.1 H. P. was the maximum load. Then, as nearly as we can determine, the following is a correct showing of the efficiencies of the wheels at full, ¾, ½ and ¼ loads respectively:

Full	load	—	703.1	H. P.	—	81.2%	efficiency
¾	"	—	516.0	"	—	78.3%	"
½	"	—	308.0	"	—	68.0%	"
¼	"	—	179.0	"	—	79.6%	"

As previously stated, we think an error exists in the reading of water at the quarter load point and that the efficiency above shown at that point is unreliable.

We are also of opinion that if the dynamometer was set to transmit a maximum load of 750 H. P. the efficiencies at various loads above shown would remain substantially unchanged.

5th: Tests for variation of speed for heavy changes of load as shown in table 5 indicate, that in this particular, the guarantee given has been fully complied with.

Hence, we recommend that when the above-mentioned defects of the by-pass valves and oil-pumps be properly made good and reliable and when dynamometers have been so adjusted that they shall measure a maximum transmitted load of 750 H. P., that these water wheel units be accepted with such deductions as may be mutually agreed upon as a fair allowance to the Power Development Co., as compensation for the fact that these wheels do *not* show exactly the guaranteed efficiencies; or, that the Girard Water Wheel Co., be required to replace these wheels with such others as will show the efficiencies required under the contract.

Very respectfully submitted,

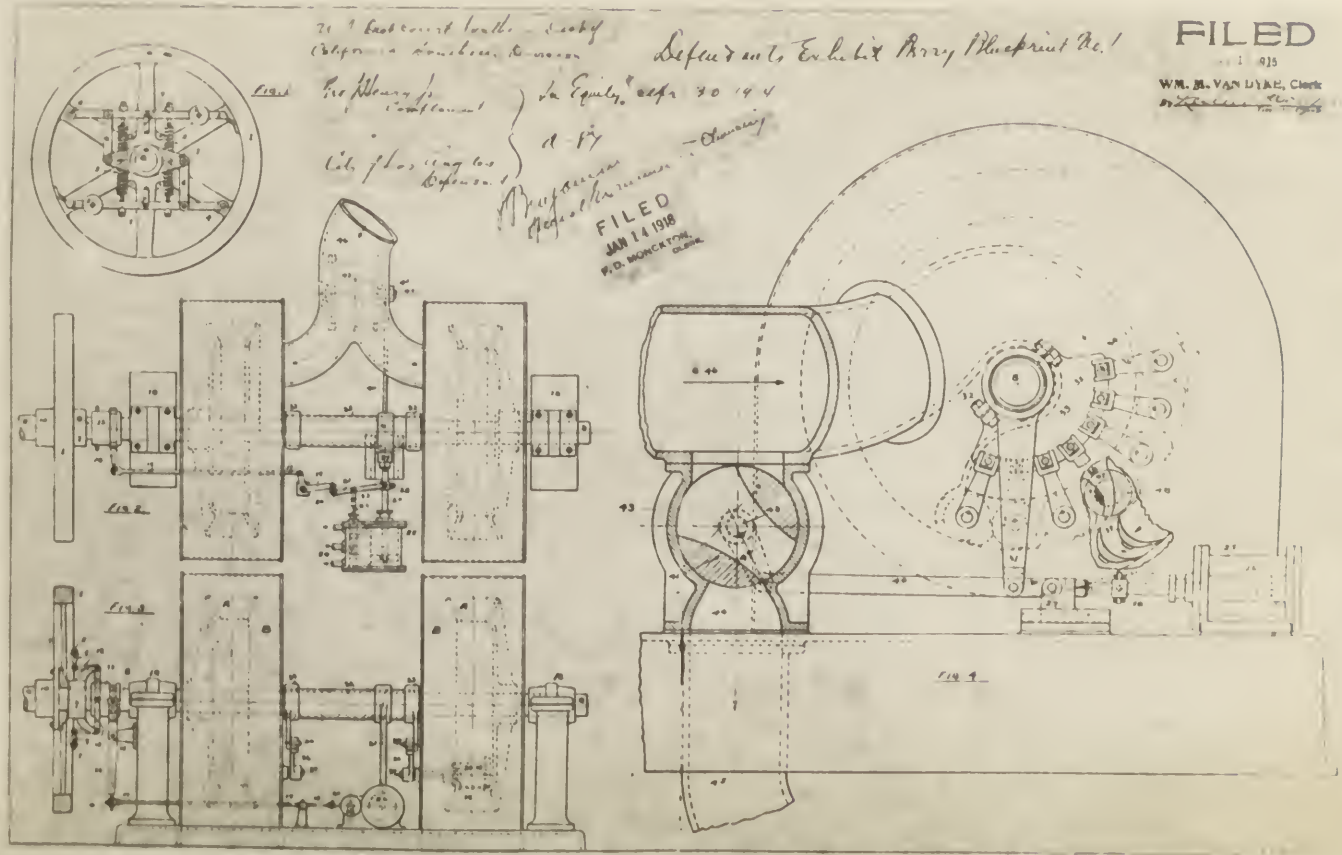
COBB & HESSELMEYER,
Engineers.

A blue print of Tables, data, etc., accompanies this report.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. Geo. J. Henry, Jr., Complainant, vs. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit Cobb Efficiency Report. April 2, 1914. J. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Report Efficiency Tests of the Girard Water Wheels at the Power House of the Power Development Company, San Francisco, Cal. Aug. 24, 1897. Edw. S. Cobb.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.


Defendants Exhibit Berry Blueprint No. 1
FILED
WM. M. VAN DYKE, Clerk
FILED
JAN 14 1918
P.O. MONCKTON, CLERK
Fig 1
Fig 2
Fig 3
Fig 4

Defendant's Exhibit Lamb Patent.

2—390.

UNITED STATES OF AMERICA,
DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the

Letters Patent of
Newton Lamb,

Number 668,801, Granted February 26, 1901,
for

Improvement in Regulating Devices for Impact Water-Wheels.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 25th day of February, in the year of our Lord one thousand nine hundred and fourteen and of the Independence of the United States of America the one hundred and thirty-eighth.

[Seal] J. T. NEWTON,
Acting Commissioner of Patents.

2—370.

No. 668,801.

THE UNITED STATES OF AMERICA,

To all to whom these presents shall come:

WHEREAS, Newton Lamb,
of
Yreka, California,

has presented to the Commissioner of Patents a peti-

tion praying for the grant of Letters Patent for an alleged new and useful improvement in

Regulating Devices for Impact Water-Wheels,

a description of which invention is contained in the specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of law in such cases made and provided; and

Whereas upon due examination made the said claimant is adjudged to be justly entitled to a patent under the law;

Now therefore these Letters Patent are to grant unto the said Newton Lamb, his heirs or assigns for the term of seventeen years from the twenty-sixth day of February, one thousand nine hundred and one, the exclusive right to make, use, and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the City of Washington, this twenty-sixth day of February, in the year of our Lord one thousand nine hundred and one, and of the Independence of the United States of America the one hundred and twenty-fifth.

[Seal] F. L. CAMPBELL,
Assistant Secretary of the Interior.

Countersigned:

C. H. DUELL,
Commissioner of Patents.

No. 668,801. Patented Feb. 26, 1901.

N. LAMB.

REGULATING DEVICE FOR IMPACT WATER WHEELS.

(Application filed Apr. 2, 1900.

(No Model.) 2 Sheets—Sheet 1.

Fig. 2.

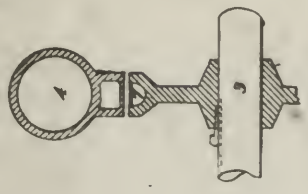
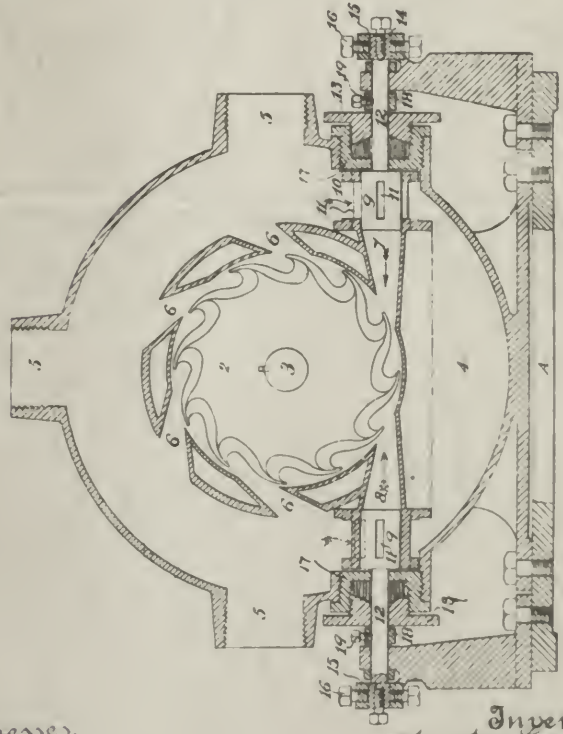


Fig. 3.

Fig. 1.



Witnesses,
E. L. Brandau,
J. [illegible]

Inventor,
Newton Lamb
By Dewey Thurston & Co.
Atts.

No. 668,801. Patented Feb. 26, 1901.

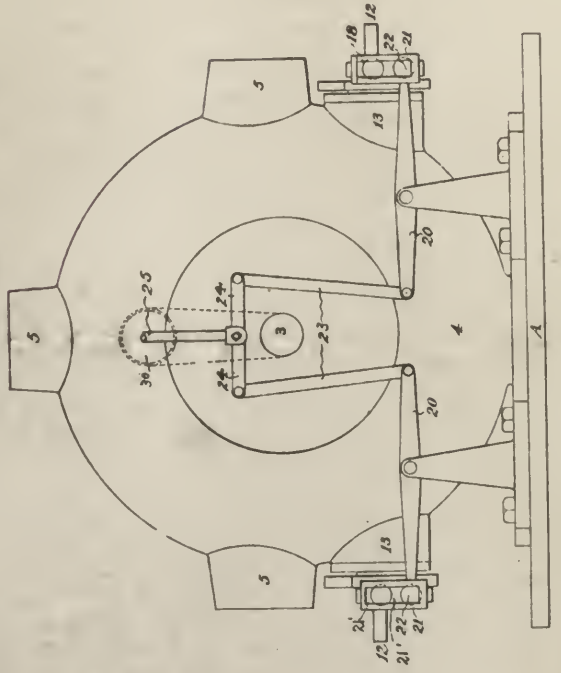
N. LAMB.

REGULATING DEVICE FOR IMPACT WATER WHEELS.

(Application filed Apr. 9, 1900.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 4.



Witnesses,
E. A. Brandau
J. H. Smith

Inventor,
Newton Lamb
by Drewry Thong & Co
Attys

UNITED STATES PATENT OFFICE.

NEWTON LAMB, OF YREKA, CALIFORNIA.

REGULATING DEVICE FOR IMPACT WATER-WHEELS.

SPECIFICATION forming part of Letters Patent No. 668,801, dated February 26, 1901.

Application filed April 2, 1900. Serial No. 11,131 (No model.)

To all whom it may concern.

Be it known that I, NEWTON LAMB, a citizen of the United States, residing at Yreka, county of Siskiyou, State of California, have invented an Improvement in Regulating Devices for Impact Water-Wheels; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to improvements in water wheels or motors and governors.

It consists of a plurality of nozzles through which water is directed against peripheral projections upon the wheel by which the latter is propelled, with a reverse nozzle through which water may be directed to retard the wheel, means for supplying water to these nozzles, valves within these nozzles, and means for operating the valves of the driving-nozzles and the valve of the retarding-nozzle reciprocally, so that whatever amount of water is shut off from a driving-nozzle is discharged by the reverse or compensation nozzle, all with and for the purpose of varying the speed and power of the wheel proportionately to its load.

My invention also comprises details of construction, which will be more fully explained by reference to the accompanying drawings, in which—

Figure 1 is a vertical section through the wheel at right angles to the shaft. Fig. 2 is a section of a portion of the wheel, taken at right angles to Fig. 1. Fig. 3 is a transverse section through one of the valves. Fig. 4 is a front elevation of the reservoir and governor connections.

In the operation of wheels, especially that class known as "momentum-wheels," in which the water is delivered into the wheel-buckets under a high head or pressure, it is desirable to regulate the speed of the wheel and make it commensurate with the load to be carried.

In order to effect this, I have shown a system of nozzles so arranged as to discharge water upon the wheel at various points around its periphery, and one or more of these nozzles is provided with a valve actuated by the governor, while on the opposite side is a nozzle to direct water against the advancing side of the wheel, which I call a "brake-nozzle." This nozzle is also provided with a valve which is operated in unison with the valve controlling the driving nozzle, so that as the supply though the driving-nozzle is decreased the supply through the brake-nozzle is increased, and by this means the movement of the water in the pipe will never be choked or disturbed, while the regulation will be more prompt than if deflecting-nozzles are used and with a less waste of water, because instead of being thrown away the water will be projected against the opposite side of the wheel to act directly in checking its movement.

The proportion of driving-nozzles to the brake-nozzle may be varied to suit conditions. As at present shown I have illustrated my invention as provided with five driving-nozzles and one brake-nozzle, which will provide for a variation of nearly fifty per cent of the load and that is more than is usually required.

In the drawings, A is a platform or frame upon which the wheel is carried. It may be in the form of a box-frame, so that the wheel-journals will stand low upon it and the wheel may project partially down into the box, and in this construction the governor bearings and supports will also be low and the whole apparatus will be more steady and compact.

2 is the wheel, mounted upon a journal-shaft 3, which turns in suitably-supported boxes at opposite sides, and there is an opening through the frame below the wheel for the free escape of water. Encircling the wheel and separated therefrom a sufficient distance to permit of the introduction of the nozzle is the reservoir or supply-pipe 4. Into this reservoir are openings 5, (there may be one or more), by which the desired head or pressure is admitted. The object of using the reservoir 4 (which *per se* is not claimed as new) to which to connect the nozzles is that it offers a ready means of water connection between these various nozzles. By using a number of these passages the reservoir may be made smaller in size, and the water entering through so many points will have a shorter distance to travel to the wheel-nozzles 6, through which water is discharged into the buckets 7 of the wheel.

I do not limit myself to any special construction of wheel or the buckets therefor, as there are many varieties of these wheels, any of which can be used in conjunction with my invention.

The nozzles 6 pass through the inner rim of the reservoir 4, which surrounds the wheel, as shown, and as many of these nozzles may be employed as desired to direct to direct water into the buckets of the wheel for the purpose of propelling it.

8 is a nozzle opening directly against the advancing face of the wheel and in opposition to one of the nozzles 6. I have only shown one of these brake-nozzles 8, because by the connection of its controlling-valve with the controlling-valve of the opposing nozzle 6 I cut off a supply from one of the direct nozzles and throw a similar amount of water into the brake-nozzle, so that the resistance to the wheel will be sufficient for any reasonable variation of load.

The valves 9 are cylindrical in form, turning in inclosing cases 10 within the reservoir 4, and the valves and casings have ports in the sides, as shown at 11, which may be brought to coincide, so as to admit water freely into the interior of the valves; but by turning the valves with relation to the casing-openings these ports may be cut off or reduced in size to any desired extent, as will be hereinafter described. One end of the valve 9 opens directly into its nozzle 6 or 8, and the other end is closed, and a shaft 12 extends axially from it through a stuffing-box 13, which forms a tight joint with relation to the shaft. The outer end of the shaft has a center against which an adjustable screw 14 may be caused to press, being turned, through threads in its support 15, to a proper bearing and then being locked by screws 16. This prevents the backward thrust of the water causing too much friction on the moving parts.

17 is a bushing which is screwed or fitted in the front end of the stuffing-box 13.

The valves are turned by crank-arms 18, which are secured to the shafts 12 by set-screws 19 or like securing devices, and the crank-arms are connected with oscillating levers 20 by links 21 or other suitable connecting devices. In order to make these parts freely movable and substantially without friction, I prefer to form them with some well-known form of ball-and-socket joint or connection, which will include balls 22 on the outer ends of the levers and operating between socketed blocks 21′, of any well-known type, mounted in links 21.

In Fig. 4 the dotted lines passing around the axle 3 and over the pulley-wheel 30 above it represent a simple and well-known arrangement by which power is transmitted by any well-known means to operate a governor, and in practice the valves 9 are intended to be controlled by some well-known form of governor (not shown) through a rod 25. Thus a lift or depression, as the case may be, of the rod 25 operates to move the valve of the driving-nozzle and the valve of the brake-nozzle simultaneously. In practice it should be understood that when the valve of the driving-nozzle is open that of the brake or retarding nozzle is closed, or vice versa, so that through the action of the governor on the rod 25 as the valve of the driving-nozzle is closed that of the brake-nozzle is correspondingly opened and the same amount of water is being discharged continuously from the reservoir, though with varying effects of power. By the simultaneous movement of the valves, as shown, compensation is made for the immense pressure that would otherwise suddenly be put upon the mains and reservoirs if the valves worked independently, though the time between the shut-off of one and the turning on of the other occupied but the fraction of a second. This feature of compensation and of controllable distribution of pressure, water, and power is the essence of my invention.

When the wheel is running, water is admitted through all of the driving-nozzles into the buckets of the wheel and the wheel is rotated by the impact of this water. The water escapes at each side of the wheel, which is open for that purpose in the usual manner of this class of wheels. When the wh reaches the speed at which it is designed to run, the governor will commence to close the inlet-valve which controls one of the supply-passages and, acting through the connecting-levers, will correspondingly open the brake-valve, thus allowing water to enter through this valve to the nozzle 8, which, acting directly against the advancing wheel, retards its motion. As soon as the motion of the wheel is reduced or begins to fall below the desired rate of speed the position of the valves will be again changed by the action of the governor, and thus the speed can be maintained.

It will be manifest that other forms of valves may be used and that various connections between the governor and the valves may be employed without altering the character and operation of the device, which is also applicable to any class of pressure-wheels.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a water-wheel, a nozzle through which water is delivered to propel the wheel, a second nozzle directed oppositely thereto, means for connecting said nozzles, valves for controlling the supply to said nozzles and controlling means connected with each valve and operating the valves to simultaneously open one and close the other.

2. The combination with a water-wheel, of a nozzle at one side of the wheel and through which water is supplied to propel the wheel, a second nozzle at the opposite side of the wheel to retard its motion, means for connecting the nozzles, valves within said nozzles, and means connected with each valve to simultaneously open one valve and close the other.

3. The combination with a water-wheel having peripheral buckets, of a nozzle through which water is projected to propel the wheel,

a second nozzle opposing the first-named one and adapted to retard the movement of the wheel, means for connecting the nozzles, valves for controlling the admission of water to the nozzles, and means including fulcrumed levers and link connections between the valves and arranged to simultaneously open one valve and close the other.

4. In a motor the combination of a journal-shaft and a water-wheel having peripherally-attached-buckets, and encircling reservoir, or supply-pipe, a nozzle attached thereto so as to discharge against these buckets and propel the wheel, and another nozzle in this reservoir so placed as to discharge oppositely against the wheel and retard its motion, valves within these nozzles, connections by which the valve of the driving-nozzle may be closed or opened simultaneously with the opening or closing of the valve of the retarding-nozzle, whereby as an amount of water is cut off by the movement of the valve at the driving-nozzle, a corresponding amount of water is discharged through the retarding nozzle without extra strain upon the mains and reservoir and whereby the speed of the wheel and the power generated therefrom are regulated.

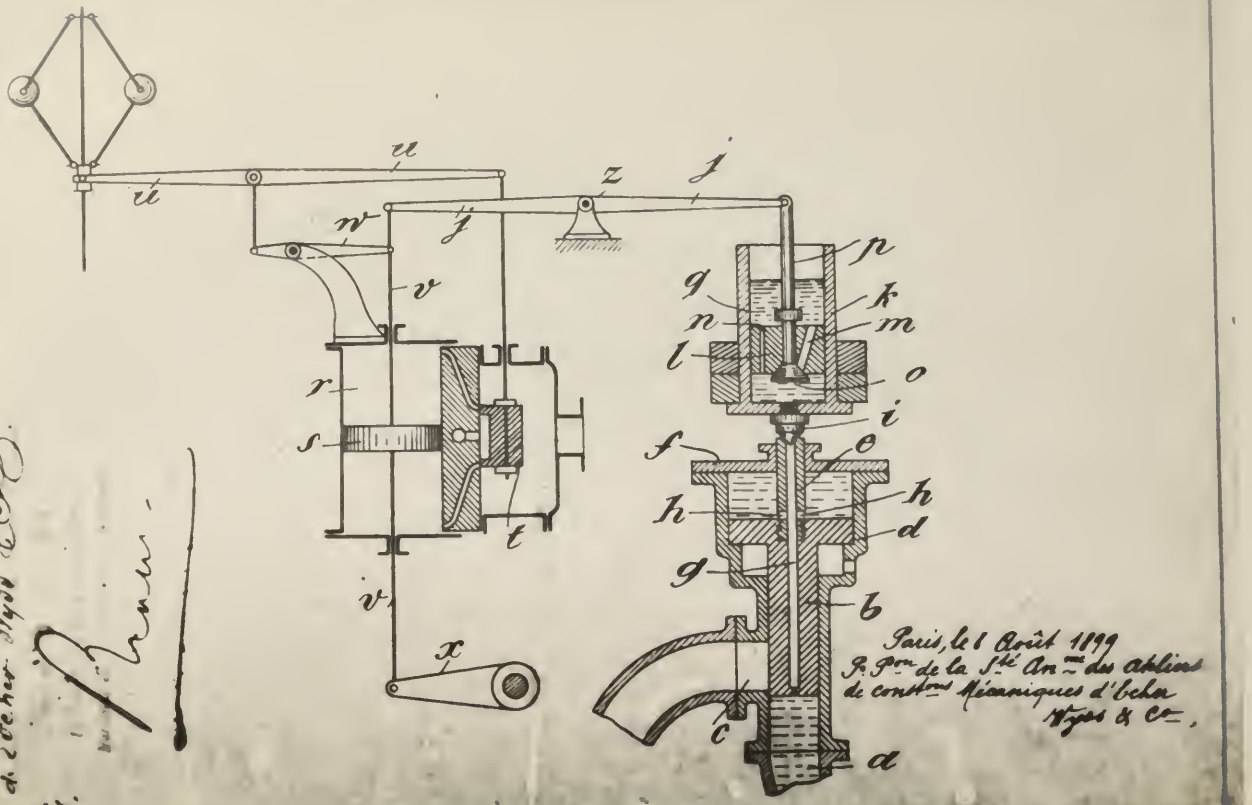
In witness whereof I have hereunto set my hand.

NEWTON LAMB.

Witnesses:
LOUIS NEHRBOSS,
J. A. WINSELL.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. George J. Henry, Jr., Complainant, vs. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit Lamb Patent. Apr. 2, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.



Brevet de quinze ans
du 8 août 1899
pour la Cie anonyme des Ateliers
de Pontcardon mécaniques
et d'Electricité (A. C.).

Paris, le 8 Août 1899
P. P.on de la Sté Anne des Ateliers
de constns Mécaniques d'Echa
Wyss & Co.

Defendant's Exhibit Translation of French Patent.

FRENCH REPUBLIC.

ADMINISTRATION OF COMMERCE AND INDUSTRY.

National Conservatory of fine arts and trades.

National office of industrial property.

Official copy of a patent of invention issued under the number 291588.

Descriptive memorandum adjoined to the patent of invention, of fifteen years, taken August 8, 1899, by the machine factory of Escher, Wyss & Co., incorporated, represented by Mr. Bletry, Senior, 2 Boulevard Strasbourg, Paris, and which was delivered to him by order of the Minister of Commerce, Industry, Post and Telegraph the 23 day of November, 1899, for a self-regulating by-pass for the water-wheel.

Our invention concerns a self-regulating by-pass for the water-wheel with the idea of over-coming the increase of pressure produced by the too rapid changes of the motive power, especially in long conduits. For this purpose one places at the water-gate a diversion, provided with a closing body, connected by a combination of levers to the governor. By this arrangement when the water-supply to the water-wheel is interrupted by the governor, the by-pass opens and closes slowly, so that the re-tained water at the gates of the water-wheel and the resultant increase of pressure are diverted through the open by-pass. The design demonstrates the construction of the by-pass, partly in vertical section and partly in diagra*m*atic view.

At the entrance of the water-wheel, the by-pass A is placed on the feed-pipe; in the pipe A is moving a differential piston B, which regulates the orifice of the flow of the by-pass. The differential piston B is placed in a vertical cylinder, the larger pressure surface of which is at the top; the said piston is guided through the bottom of the cylinder F by the rod E of the piston. All through the length of the differential piston and the piston-rod runs a narrow bore G, which opens on the outside of the cylinder at the end of the piston-rod and inside of the cylinder by means of side openings H cut through said rod. The bore G establishes a connection between the chambers above and below the piston. Over the opening of the bore G outside of the cylinder is placed a closing apparatus I, fixed to the bottom of the cylinder of an oil regulator K. In this regulator moves a piston L which is equipped with two bores a wide one M, and a narrow one N; the latter gives permanent communication between the chambers above and below the piston. The wider bore, when the piston rises, is closed at the bottom by means of a valve formed by a collar O, on the piston-rod P, placed vertically and on which the piston moves with a little play Q in vertical direction.

When the piston descends with the rod, the latter moves slightly toward the bottom, opens the bore M, and *and* the communication between the chambers above and below the piston, is accomplished also by the bore M.

To the piston-rod P is connected a double-arm lever Y which is brought into action by the regular

governor. Said governor consisting as usual in a cylinder R with a piston S and a slide-valve T, is operated by a regulating lever U connected directly to the rod of the slide-valve T by means of an intermediate lever W joined to the piston-rod S. The piston-rod V is connected by a lever X to an admission-valve (moderator) in such a way that when the piston S and the piston-rod go down, the admission-valve of the water-wheel closes. The lever J which is connected at one end with the piston-rod P, and at the other end is joined to the piston-rod V, oscillates on a support Z. As the running of the water-wheel accelerates, the piston-rod V descends and closes the admission-valve, then the lever J lifts the piston-rod P and the regulator of the by-pass works in the following manner:

Through the opening H, the compressed water which rises through the bore G, pours into the chamber above the differential piston and exercising a pressure on a surface greater than the one below the piston, it pushes said piston down and closes the discharge pipe C of the by-pass. This position almost corresponds to the normal run of the water-wheel. The cylinder K of the regulator, which closes the opening of the piston-rod by a valve I, slowly follows the descending movement of the differential piston, and the oil in this cylinder slowly pours through the narrow bore N into the chamber below the piston. When the governor, by means of the moderator (admission-valve) diminishes the diameter of the feed-pipe of the water-wheel the piston-rod V descends as it has been said, turns the lever J on its support and

lifts the piston-rod P. As through the narrow bore N of the piston L the oil pours very slowly, the whole oil regulator is lifted, and the valve I is removed from the opening of the bore of the piston B. Escaping through the opening of the bore E the water diminishes the pressure on top of the differential piston, and consequently the pressure from below lifts the piston B. So the piston B is pushed up and opens the orifice of the discharge which remains open during the time the diameter of the admission-pipe of the water-wheel is diminished. While the differential piston B rises, the piston-rod E meets the valve I which closes again the opening of the bore G, and above the piston B reestablishes the necessary equilibrium.

Whenever the regulating body performs an entire or partial displacement, the differential piston can only follow it in the same proportion, and the opening C of the by-pass opens in proportion to the closing of the water-gate. Consequently the same amount of water issues through the conduit of the by-pass as is refused by the moderator at the water-gate.

As soon as the governor retakes its position which corresponds to the normal run of the water-wheel, the lever J moves the piston-rod P down and said piston-rod having a play, slides in the piston L. In this way it opens the closure of the larger bore M formed by the valve O. The piston L descends in the cylinder of the regulator K, because the oil escapes rapidly toward the top through the larger bore M.

Summary.

1) A self-regulating by-pass for water-wheels characterized in the following manner: the body which closes the conduit of the by-pass is connected by a system of levers to the governor in such a way that said governor opens or closes the conduit of the by-pass according to the opening or closing of the water-gate of the water-wheel.

2) The way of the working of the self-regulating by-pass following the summary 1 is: The closing body is connected to a differential piston, both surfaces of which are sub-mitted to the pressure of water, to produce a rapid opening it is necessary to diminish the pressure on the larger surface. This is afforded by an oil regulator connected to the water-wheel governor in such a way that the rising of the cylinder of said oil-regulator diminishes the hydraulic pressure on the larger surface of the differential piston, and the weight of the falling cylinder produces a slow descending movement regulated by the work of the oil regulator and consequently closes the conduit of the by-pass.

3) A self-regulating by-pass for the water-wheels essentially and in detail as described is represented in the adjoining drawing.

Paris, August 8, 1899, per the machine factory of Escher, Wyss & Co., Incorp.

Signed, C. ELETRY, Senior.

Paris the 9 of February, 1914.

For the certified expedition confirmed.

(Seal) Secretary of the National Office of Industrial Property.

[Endorsed]: United States District Court, Southern District of California, Southern Division. Geo. J. Henry, Jr., Complainant, v. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit Translation of French Patent—April 1, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

FIG. 1.

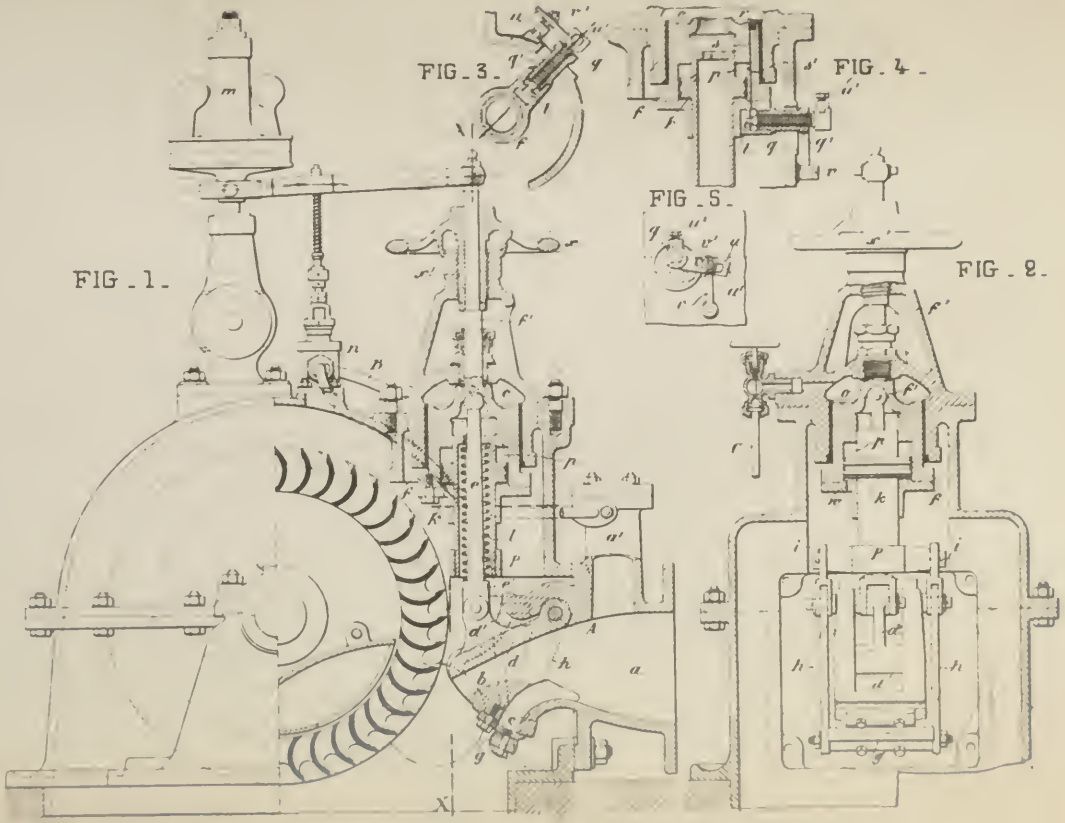


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 2.

Defendant's Exhibit Translation of Swiss Patent.

SWISS CONFEDERATION.

Confederate Office of Industrial Property.

Specification of the Patent.

Patent No. 17536. December 15, 1898, 7 P. M.

Class 93.

Irené Schaad, Kriens near Lucerne (Switzerland).

Mechanism for the automatic regulation of the by-pass at high pressure water-wheels.

The subject of the present invention is an automatically regulated by-pass for high-pressure water-wheels with the idea to avoid the impact of the water in the conduits, resulting from the sudden closing of the water-gate. A high-pressure turbine with an automatic speed-regulator answers the demands of modern industry only when it is provided with a fast working "servomotor." At water-wheels with or without short conduits, the said servomotor has a bad effect on the relation between the pressure and velocity, while in long conduits with high pressure, the thing becomes dangerous.

This evil was formerly partly avoided by inserting into the pipe a pump-kettle, putting on fly-wheels on the water-wheel shaft or applying a by-pass regulator with oil-brakes.

Pump-kettles and fly-wheels are rather ex-pensive and besides the latter is a power absorber; the by-pass-regulation by means of an oil-brake is not satisfactory because the said brake does not work directly on the regulator-valve and does not regulate the by-pass water gradually, which causes the impact of

water in the conduits, and makes impossible an automatic regulation of velocity.

These evils are removed by the mechanism for automatic by-pass regulation for high-pressure turbines which is the subject of the present patent and a drawing of which is adjoined.

Fig. 1 is a partial vertical section of the invention. Fig. 2 is a partial section through X–X of Fig. 1, while Fig. 3, 4 represent details.

The feed-pipe a is provided with two adjacent mouths, the mouth b is the channel of the water-flow upon the water-wheel and the mouth c with the same maximum orifice is the eduction channel to the by-pass. The former is represented open and the latter closed. The regulating tongue d, which is placed on a pivot z and connected by a rod e which rests on the tongue-head d′ to a hydraulic piston f by means of a pivot f′. The slide-valve of the by-pass is connected to a double-arm p, fastened to the lower end of the inner hydraulic piston k, by means of two angle-levers h which rotate on the pivot A, and their corresponding bridle-rods i. In the bore of the latter on a rod e is placed a spring l, said spring pressing with one end the forked end e′ of the rod l and with the other the upper part of the piston k has the tendency to push the latter up, i, e, to keep the slide-valve of the by-pass closed. The regulating valve n inserted in a pressure water-pipe B which issues out of the cap of the feed-pipe A and leads into the chamber above the piston f to regulate the pressure on top of said piston f by means of the governor M is regulated in accordance with the velocity. The

rapidity with which the slide-valve g is closed can be controlled at will by a regulating screw and the consumption of water accordingly reduced through a converting body v. The latter is screwed into the top of the bore s in the wall of the piston f, and is narrower than the bore s which through a side opening S′ has an outlet into the annular chamber p above the inner piston k and through a side opening t into the turbine-box. At the opening t in a screw-nut q′ placed at the bottom of the piston f is applied the regulating screw q with a conical tap. At the end of this regulating screw q is fastened by a screw u2 an arm u with a cut u′.

Through the cut u′ is inserted a pin v′ of a rod v fastened to the turbine-box, which gives to the arm u a point of support during the upward and downward movements of the piston f and regulating screw q. By this arrangement is obtained the narrowing or widening of the opening t in accordance with the turning of the regulating screw q in one direction or the other.

For the purpose of a quick stop of the turbine another water-pipe C affords a direct flow of the pressure-water into the chamber o above the piston f. A hand-wheel x placed on a slide x′ of the piston-rod f2 of the piston f performs the starting and stopping of the turbine and also to widen or narrow the orifice of the channel b to suit the conditions of the time being. A hole in the bottom of the piston f allows the escape of the leaking water.

The described by-pass regulator works as follows: Before starting the turbine, the regulating screw q

is adjusted at the opening of the outflow bore t in such a way, that during the normal run of the turbine the resistance on the spring l is somewhat greater than the pressure in the chamber p so that the slide-valve can be kept closed.

As soon as the water-pressure in the chamber o above the piston f is increasing by means of the governor m, the tongue d is moving down; at the same time the water-pressure in the chamber p over the inner piston f will be correspondingly higher, and the slide-valve g is opened in proportion during which the strain of the spring l remains almost unchanged, so that the stream in the conduits while closing the tongue d continues the same. If by the influence of the governor the tongue d took any other resisting position, the pressure in chambers o and b has lessened the equilibrium, so that the over-pressure by the spring l results, and closes the slide-valve g. The suppressed water in the chamber p, works like a brake on the rising piston k and reduces the speed of the total closing of the slide-valve of the by-pass.

The water-pressure on the regulating tongue d is the highest while the said tongue completely closed and lowest while opened; to keep the equilibrium in the same proportion as the regulating tongue is moved toward closing or opening, the governor must produce changes of pressure on the piston f to keep the equilibrium.

The closing time of the slide-valve g must as little as possible depend on such changes of pressure. That can be obtained by means of the regulating

screw in the following manner; whenever the piston f through the increase of pressure in the chamber o, is moved down, the regulating screw q is turned around in this particular case so that it widens the outflow opening t, letting more water through r and t and by the same decreasing proportionately the pressure on the piston k. As a result of the over-pressure of the spring l, the piston k is raised, and the channel of the by-pass accordingly closed. The outflow opening t widens in proportion to the position of the tongue d, so the closing-time is almost independent of the increase of pressure in the chamber p, produced by the closing of the by-pass channel in proportion to the position of the tongue d.

In the opposite case, or when the turbine slackens speed, the mechanism works as follows; by means of the governor, the pressure in the chamber o is decreasing, and the following increase of pressure on the tongue d opens the water-gate. The by-pass could be already closed or would be closed with the same speed as the tongue is opened.

The relation between the orifices can be previously estimated with all certainty so the automatic regulation of the by-pass is not accidental as it was formerly with oil-brakes and closing with constant speed.

Patent claims.

1) Mechanism for automatic regulation of the by-pass for high-pressure water-wheels, which by means of a governor can be operated by a hydraulic servomotor and is characterized as follows;

The entrance to the turbine is provided besides the

water-gate, with a by-pass. In the inside of piston f which is connected to the regulating tongue d is placed under the activity of a spring l a piston k, which is connected to the slide-valve g of the by-pass. The chamber above the piston f which intakes the water through the regulating valve of the servomotor, is connected to the chamber above the piston k by means of a bore s in the wall of the piston f with a side opening s′.

At another side opening t of the said bore s is applied a regulating screw in such a way that the increase of pressure above both pistons produced by the regulating-valve as a result of speed increase of the governor, can narrow the inlet orifice of the water-gate by means of the tongue d, and at the same time open the by-pass channel. In the opposite case or when decrease of pressure on the piston f, produced by the resistance and slowing down of the rotation of the governor, the spring l gets the over-pressure and closes the by-pass channel with also decreasing speed avoiding the impact of the water in the conduits at the fast closing up of the water at the water-gate of the turbine.

2) An arrangement of the mechanism described in claim I by which a regulating screw q, applied to the opening t of the piston f, is connected to a point of support by an arm u in such a way that when the piston moves up-ward and turns the arm u the opening t widens in proportion to the position of the tongue d. That is arranged with the idea of closing the by-pass channel with gradually diminishing velocity independently of the variations of the pres-

sure on the pistons f and k, when over-pressed by the spring l, the piston k ascends.

IRENE SCHAAD.

Represented by A. Ritter, in Basel.

CERTIFICATE.

It is hereby certified that the present specification of the patent issued July 15, 1899, corresponds to the principles, by which is protected the

Patent No. 17536, dated December 15, 1898, 7 P. M. (date of the delivery of the patent-request) and registered May 15, 1899, under the name of Irené Schaad, Kriens near Lucerne (Switzerland).

This patent expired December 15, 1905.

Bern, February 12, 1914.

Conf. Office of Industrial Property Director,

(Signed) HALLEZ.

[Endorsed]: United States District Court, Southern District of California, Southern Division. Geo. J. Henry, Jr., Complainant v. City of Los Angeles, Defendant. In Equity—A–87. Defendant's Exhibit. Translation of Swiss Patent. Apr. 1, 1914. I. Benjamin, Special Examiner in Chancery. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

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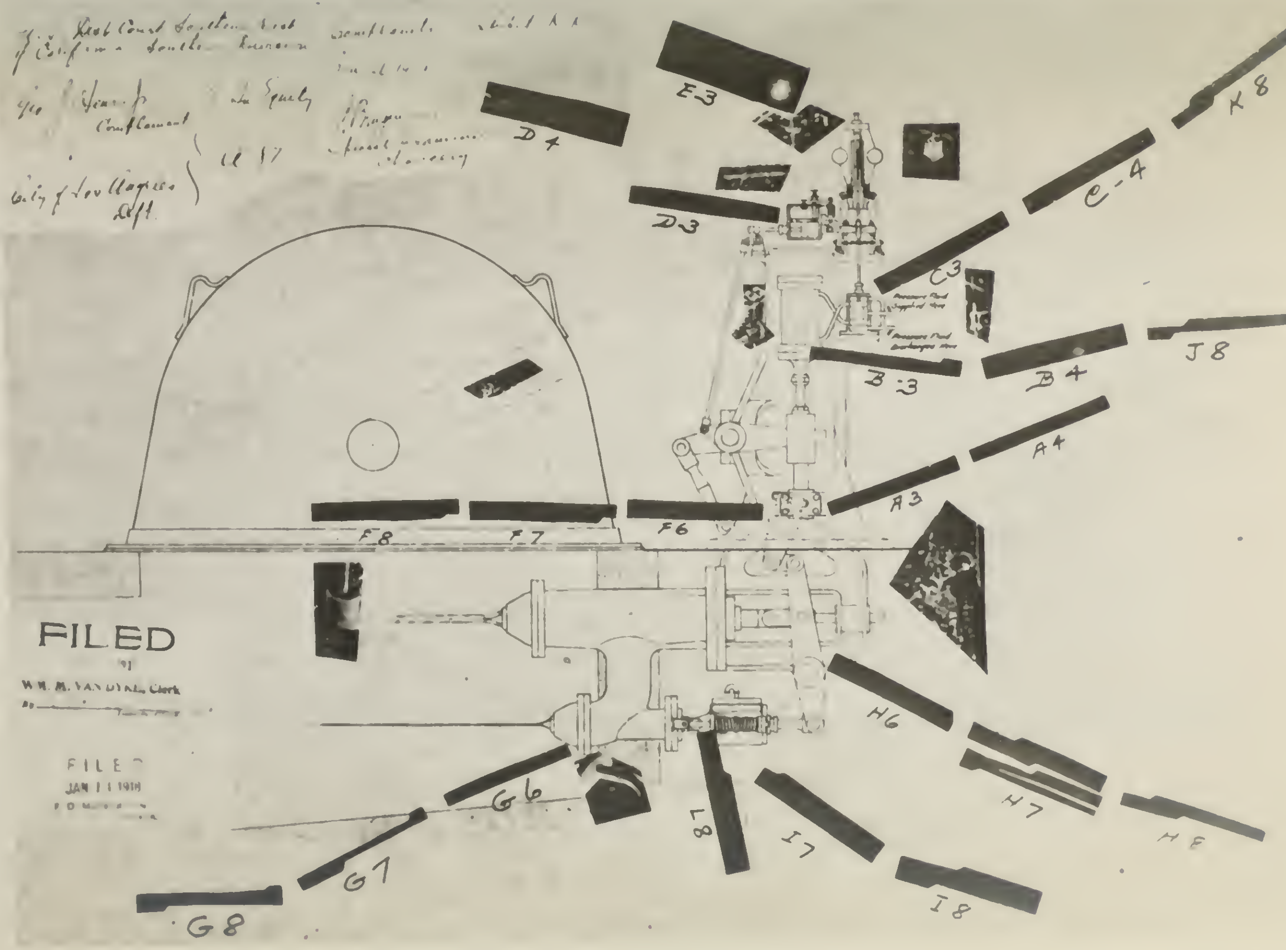
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U.S. Dist. Court, Southern Dist. of Calif., Southern Division.

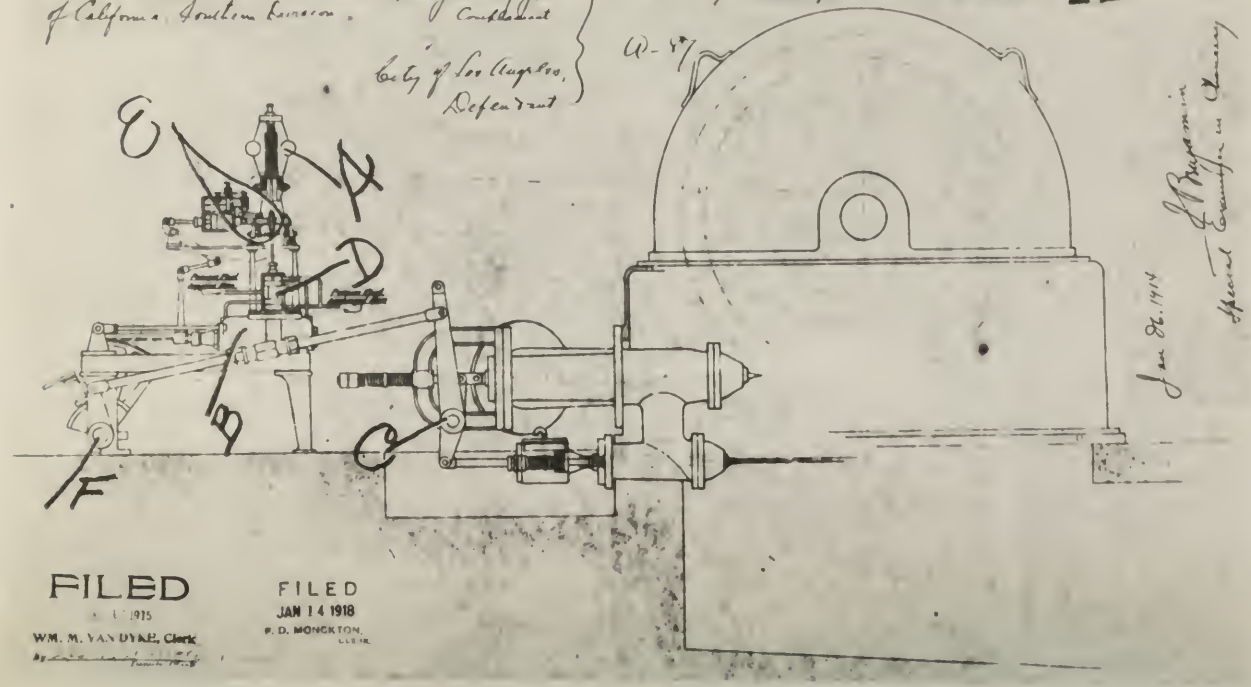
Geo. J. Henry Jr. Complainant

vs.

City of Los Angeles, Defendant

In Equity Complainant's Exhibit LL

W-87



J. J. Benjamin
Special Examiner in Chancery
Jan 26, 1914

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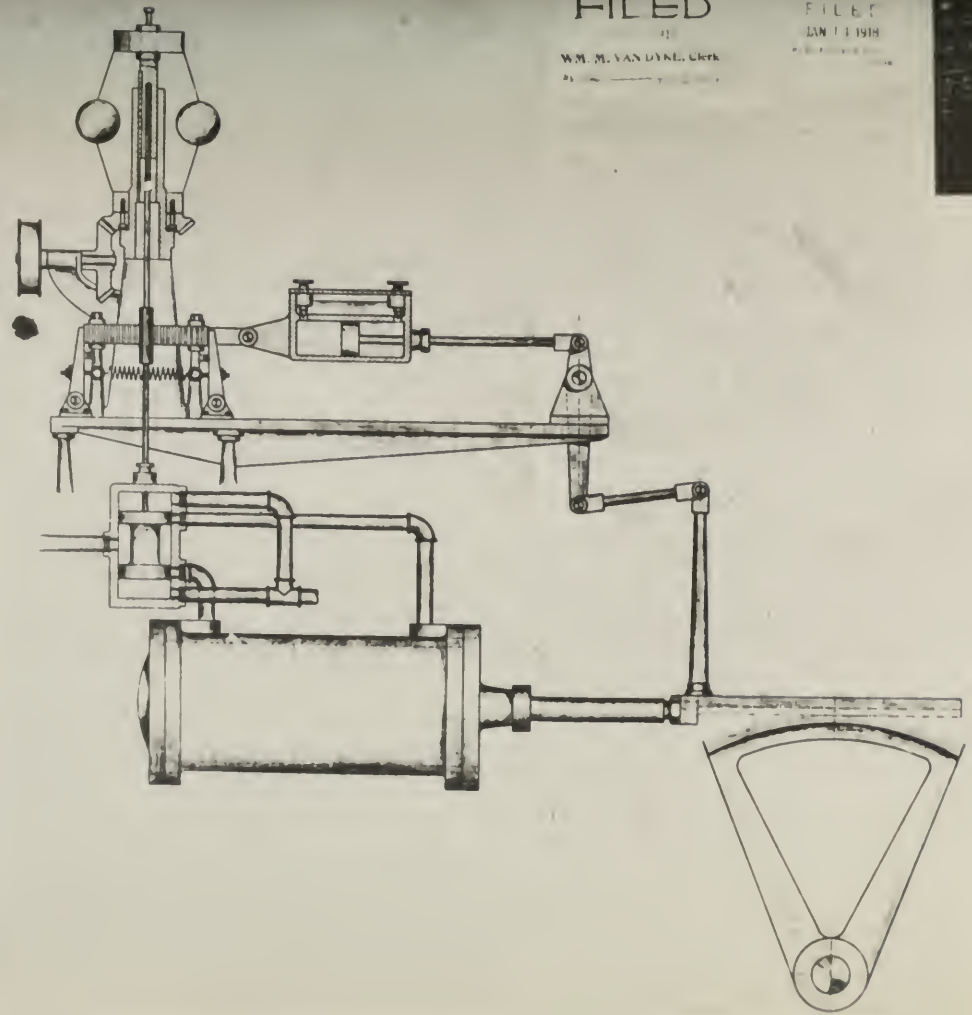

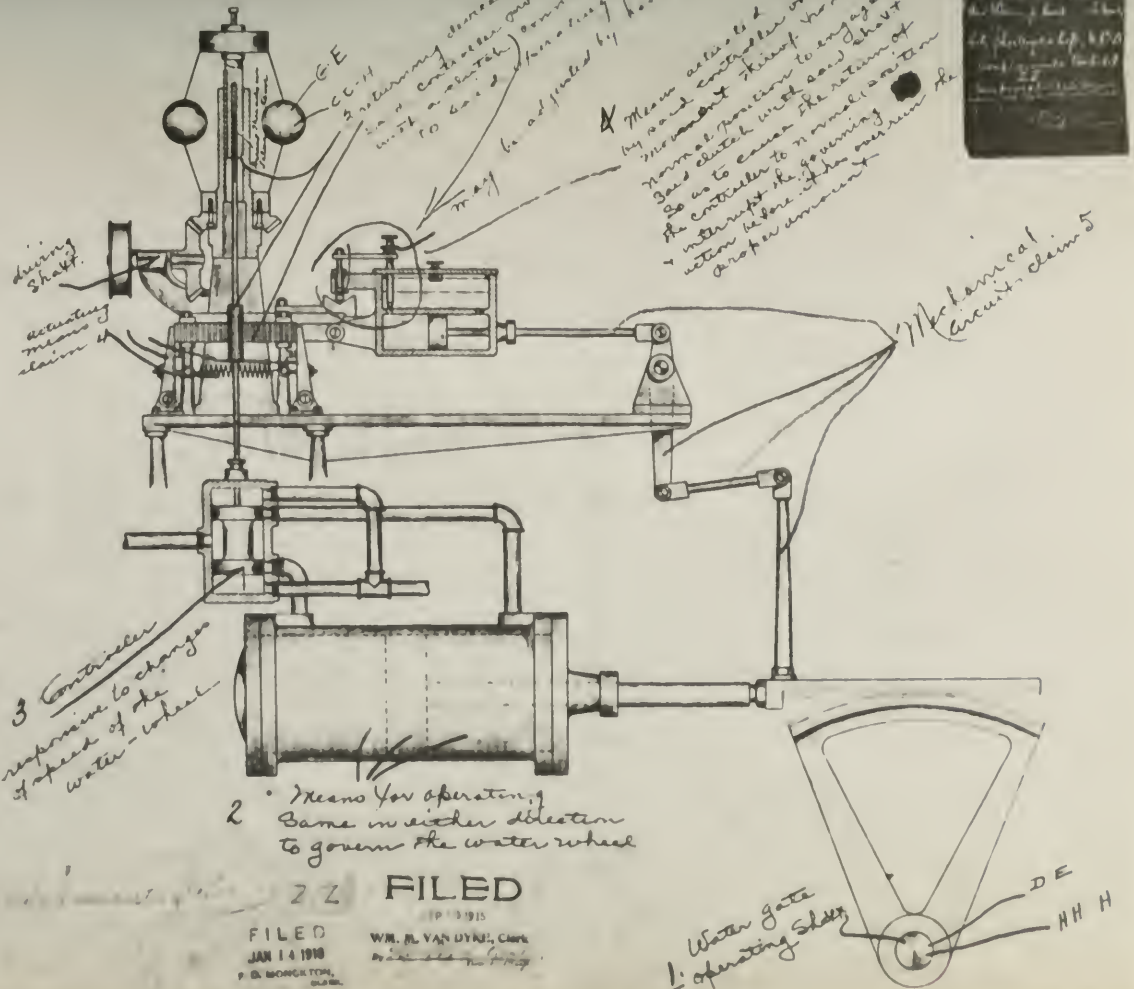

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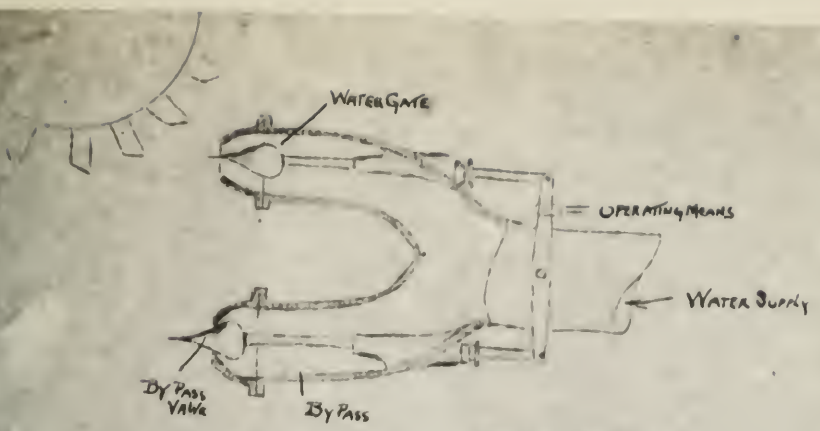

U. S. Circ. Court of Southern Dist. of California, Southern Division
Geo. J. Henry Jr. vs. In Equity
City of Los Angeles A-87
Complainants Exhibit Wilson Sketch A
Feb 16, 1915
J Bergamini
Special Examiner

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U. S. Circ. Court, Southern Dist. of California, Southern Division
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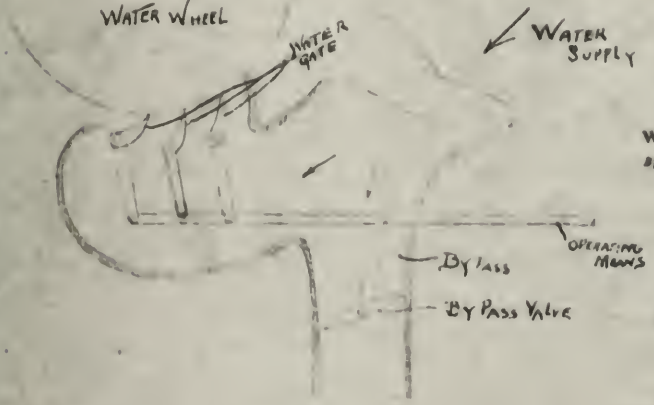

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Complainants Exhibit Wilson
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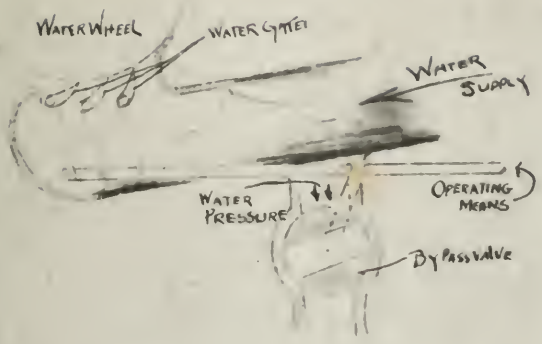
Feb 16. 1917
J. Bryan
Special Examiner



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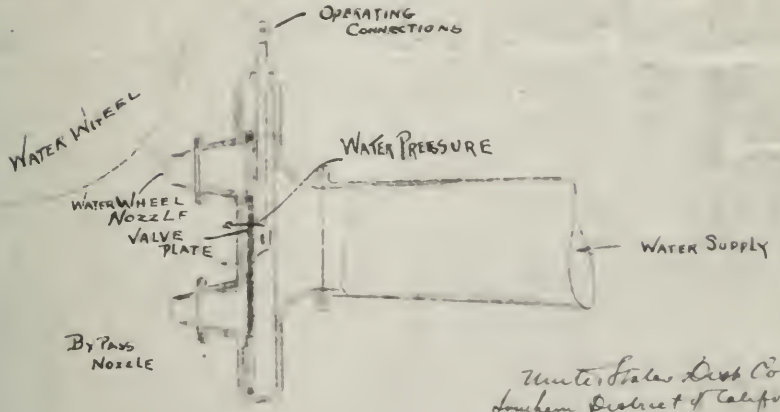

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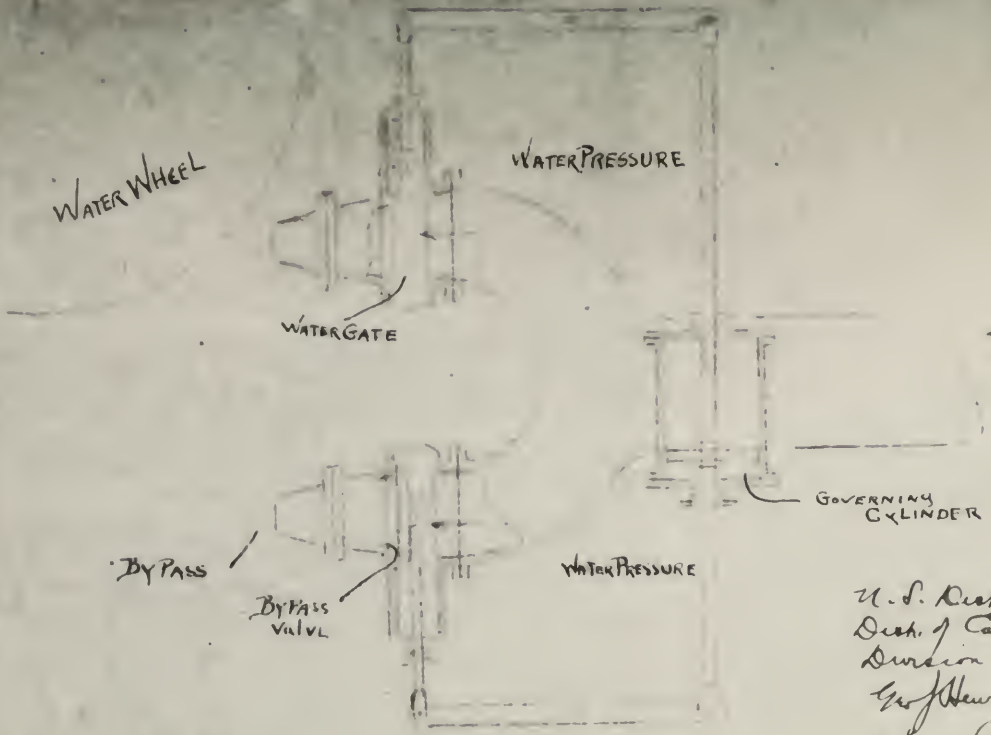

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By Leslie S. Colyer, Deputy Clerk

U. S. Dist Court, Southern Dist. of California Southern Division
Geo. J. Henry Jr. } In Equity
City of Los Angeles } A-87
Complainant's Exhibit Volume
Filed Oct. 16, 1917
J. Benjamin E
Medical Examiner

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Complainant's Exhibit Photograph D.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. George J. Henry, Jr., v. City of Los Angeles. In Equity—No. A–87. Complainant's Exhibit. Power Development Company Plant. Photograph D. Feb. 23, 1915. I. Benjamin, Special Examiner. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

Filed Jan. 14, 1918. F. D. Monckton, Clerk.

Complainant's Exhibit Photograph H.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. George J. Henry, Jr., v. City of Los Angeles. In Equity—No. A–87. Complainant's Exhibit. Power Development Company Plant. Photograph H. Feb. 23, 1915. I. Benjamin, Special Examiner. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

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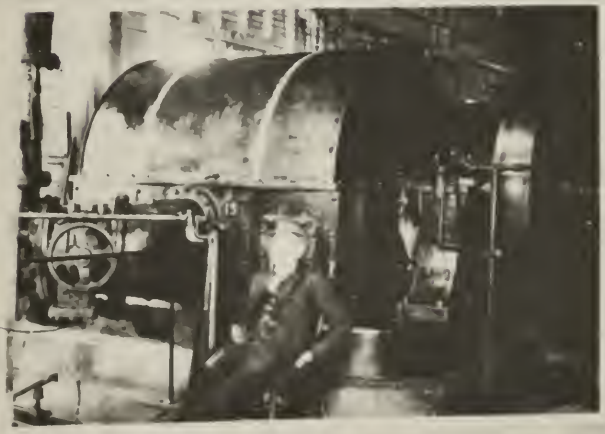

sealed outlet

Complainant's Exhibit Photograph E.

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Complainant's Exhibit Photograph A.

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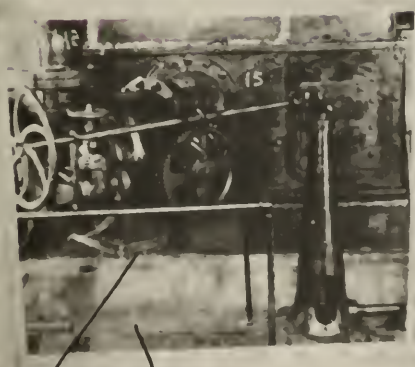

Sealed outlet

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Complainant's Exhibit Photograph B.

[Endorsed]: U. S. District Court, Southern District of California, Southern Division. George J. Henry, Jr., v. City of Los Angeles. In Equity—No. A–87. Complainant's Exhibit. Power Development Company Plant. Photograph B. February 23, 1915. I. Benjamin, Special Examiner. Filed Sep. 16, 1915. Wm. M. Van Dyke, Clerk. By Leslie S. Colyer, Deputy Clerk.

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Complainant's Exhibit Photograph I.

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